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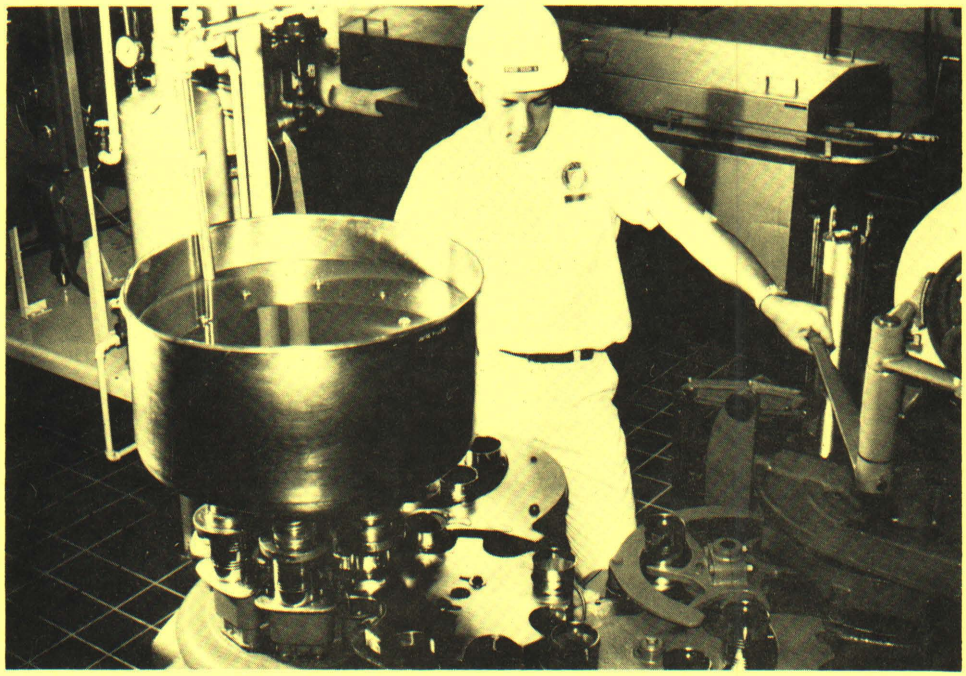

DEPARTMENT OF HORTICULTURE
The Ohio State University
Columbus, Ohio

and

Ohio Agricultural Research and Development Center
Wooster, Ohio

INDEX

EVALUATION OF SNAP BEAN VARIETIES FOR PROCESSING

by

Wilbur A. Gould

Nine varieties of snap beans were grown on the Horticultural Farm at The Ohio State University. The beans were planted in 200 foot rows, 36 inches apart with the seed placed two to three inches apart in the row depending on seed size.

At harvest, the plants were pulled and the pods removed by hand. They were transported immediately to the Fruit and Vegetable Processing and Technology Pilot Plant. The beans were mechanically snipped, size graded, spray washed, water or steam blanched and hand packed twelve ounces into No. 303 plain tin cans. Two size grades were used, 1-3 and 4-6, the latter were cut into pieces 1 to 1½ inches long, the smaller size grade were packed as whole beans. The whole beans were steam blanched for 3 minutes, and the cut beans were water blanched at 170°F. for 3 minutes. Both lots were water cooled prior to inspection and filling.

The canned snap beans were covered with boiling distilled water and a thirty-grain sodium chloride tablet was added to the can. The cans were exhausted for four minutes, steam flow closed (at 15 psi) and processed at 240°F. for 20 minutes.

The frozen snap beans were filled into freezer bags, sealed, coded, frozen in a single contact freezer (-40°F.) and stored at 0°F.

Quality was determined as follows (the results as reported in the following tables are the average values for this harvest where applicable):

Number of plants - The actual number of plants in 100 feet were pulled and counted for each of the harvests.

Yield - The beans were weighed to determine the gross yield in pounds for the number of plants in 200 foot rows and yield was calculated to ounces/plant.

Number of pods per pound - The number of pods in a one-pound field run sample was counted.

Percent sieve size - Sieve size was determined by measuring the diameter of the pod perpendicular to the sutures. The sieve sizes of a one-pound field run sample were determined and weighed. The data are shown by count, percentage by count and by weight for each sieve size.

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*The assistance of the students in Horticulture 641 class for processing the samples, is gratefully acknowledged.

Pod length - Pod length was determined by evaluating 20 pods as to average length reported in inches.

Percent by weight seeds - Determined on fresh, canned, and frozen product and reported by sieve size. For determining percent by weight seeds, 100 grams of pods for each sieve size were deseeded and the seeds weighed.

Texture - Determined on GOSUT texturometer using several pods of each sieve size to arrive at the average value. Results are reported directly in GOSUT texturometer values.

The grade for the canned and frozen products by the respective attributes of quality was deternined in accordance with the U.S. Standards for Grades of Canned and Frozen Snap Beans. The actual score points assigned each of the attributes of quality are recorded by sieve size for each of the varieties.

% Fiber - % Fiber was determined by the Official Food and Drug Method. All values are far below the maximum limit of 0.15%.)

TABLE I - SNAP BEAN EVALUATION - 1972
RAW PRODUCT

Variety	No. Growing Days	No Plants 100'	Harvest No	Yield oz./ Plant	No. Pods/ lb	Sieve Size	Count no./ lb.	Count %	% by Weight	Avg. Length in	Texture	% Fiber*	% Seeds*
Green Pod 467	65	158	1	.74	92	1	18	19.6	3.1	3.5	3		
						2	27	29.3	21.3	4.0	9	-	1.4
						3	18	19.3	21.9	4.8	16		
						4	15	16.3	22.5	5.0	18		
						5	11	11.9	21.3	4.8	22	-	2.9
						6	3	3.3	9.4	5.8			
Green Pod 467	72	153	2	3.17	63	1	5	7.9	3.1	3.6	5		
						2	4	6.3	4.4	4.4	12	.018	2.0
						3	9	14.3	11.9	4.8	18		
						4	19	30.2	33.1	5.6	21	-	
						5	15	23.8	29.7	5.1	25	.070	8.5
						6	11	17.5	22.5	5.0	28		
Early Gallatin	66	326	1	1.25	110	1	10	9.1	2.5	3.0	2		
						2	24	21.8	14.1	3.6	9	.025	1.8
						3	27	24.5	22.5	3.9	13		
						4	42	38.2	48.4	4.6	17		
						5	7	6.4	11.9	5.1	20	.037	2.9
						6	0	-	-	-	-		
Early Gallatin	72	271	2	3.17	84	1	1	1.2	.6	-	-		
						2	6	7.1	4.1	3.5	11	.033	2.4
						3	20	23.8	17.6	4.0	18		
						4	32	38.1	37.6	4.6	22		
						5	17	20.2	25.3	4.7	23	.068	8.5
						6	8	9.5	14.7	4.9	25		
Green Pod 68-115	66	190	1	.82	110	1	14	12.7	4.7	2.8	3		
						2	40	36.4	27.5	3.5	11	.016	1.2
						3	28	25.5	27.5	4.3	18		
						4	25	22.7	34.4	4.9	17		
						5	2	1.8	3.7	-	16	.037	1.6
						6	1	.9	1.6	-	18		

* % Fiber and % Seeds determined on sizes 1-3 and 4-6

Variety	No. Growing Days	No. Plants 100'	Harvest No.	Yield oz./ lb.	No. Pods/ lb.	Sieve Size	Count no./ lb.	Count %	% by Weight	Avg. Length in.	Texture	% Fiber*	% Seeds*
Green Pod 68-115	72	244	2	3.24	71	1	3	4.2	2.5	3.4	5		
						2	11	15.5	9.4	4.1	12	.015	2.2
						3	21	29.6	26.3	4.6	16		
						4	17	23.9	25.0	4.7	17		
						5	13	18.5	25.0	4.9	21	.054	5.5
						6	6	8.5	16.9	5.2	28		
Green Pod 136	66	170	1	1.22	90	1	12	13.3	4.7	3.4	3		
						2	23	25.6	16.3	3.4	10	.021	.9
						3	18	20.0	20.6	4.3	14		
						4	26	28.9	37.5	4.9	20		
						5	7	7.8	12.5	5.3	21	.045	2.0
						6	4	4.4	8.7	5.5	21		
Green Pod 136	76	190	2	5.29	49	1	1	2.0	.6	-	2		
						2	2	4.1	1.9	-	11	.012	2.2
						3	3	6.1	2.5	3.7	14		
						4	11	22.4	18.8	5.1	20		
						5	16	32.7	36.3	5.6	23	.067	8.3
						6	16	32.7	40.6	5.5	27		
Green Pod 317	70	195	1	1.56	93	1	16	17.2	6.9	3.3	5		
						2	11	11.8	9.4	4.1	14	.021	1.6
						3	18	19.3	20.3	4.4	19		
						4	41	44.1	53.1	4.4	22		
						5	7	7.5	11.9	5.0	23	.014	2.4
						6	0	-	-	-	-		
Green Pod 317	72	271	2	2.56	79	1	8	10.1	5.0	3.8	7		
						2	10	12.7	8.8	4.1	12	.031	3.0
						3	18	22.8	20.6	4.2	19		
						4	19	24.0	22.5	4.5	23		
						5	19	24.0	31.9	4.7	24	.050	7.2
						6	5	6.3	10.6	5.2	26		

* % Fiber and % Seeds determined on sizes 1-3 and 4-6

Variety	No. Growing Days	No. Plants 100'	Harvest No.	Yield oz./ Plant	No. Pods/ lb.	Sieve Size	Count No./ lb.	Count %	% by Weight	Avg Length in.	Texture	% Fiber*	% Seeds*
Avalanch	68	207	1	2.86	85	1	9	10.6	4.7	3.6	7		
						2	24	28.2	18.8	4.2	12	.016	2.0
						3	18	21.2	22.5	4.2	16		
						4	25	29.4	36.9	4.8	24		
						5	5	5.9	10.0	5.2	26	.047	6.6
						6	4	4.7	9.4	5.4	26		
Avalanch	74	272	2	4.63	66	1	1	1.5	1.3	-	5		
						2	6	9.1	5.0	4.2	8	.015	4.0
						3	6	9.1	3.8	4.2	16		
						4	26	39.4	38.8	4.8	20		
						5	16	24.4	28.1	4.8	23	.073	13.6
						6	11	16.7	3.1	4.8	25		
Tender Crop	70	137	1	2.37	105	1	17	16.2	6.2	2.9	3		
						2	25	23.8	18.8	3.8	12	.017	1.5
						3	19	18.1	18.8	4.0	16		
						4	29	27.6	35.0	4.0	18		
						5	11	10.5	18.1	4.8	24	.056	3.2
						6	4	3.8	6.9	4.6	27		
Tender Crop	76	140	2	5.30	74	1	6	8.1	1.9	2.5	3		
						2	4	5.6	2.5	2.9	6	.014	3.2
						3	11	15.3	11.3	4.2	16		
						4	32	44.4	44.4	4.5	21		
						5	14	19.4	26.9	5.1	25	.045	8.5
						6	7	9.7	13.1	4.8	28		
Sunbeam	69	211	1	2.42	98	1	1	.6	-	-	-		
						2	28	28.6	18.8	4.0	11	.014	3.0
						3	29	29.6	28.1	4.4	19		
						4	31	31.6	38.8	3.3	23		
						5	9	9.2	15.6	5.3	24	.042	11.6
						6	0	-	-	-	-		
Sunbeam	74	224	2	3.23	82	1	0	-	-	-	-		
						2	3	3.7	2.5	4.0	10	.017	4.1
						3	13	15.9	12.5	4.3	18		
						4	53	64.9	66.9	4.6	21		
						5	12	14.9	18.1	4.6	26	.037	13.3
						6	1	1.2	2.5	-	28		

Variety	No. Growing Days	No. Plants 100'	Harvest No.	Yield oz./ Plant	No. Pods/ lb.	Sieve Size	Count no./ lb.	Count %	% by Weight	Avg. Length in.	Texture	% Fiber*	% Seeds*
Bush Ramano	69	188	1	3.15	76	1	0	-	-	-	-		
						2	4	5.3	1.9	3.0	3	-	-
						3	3	3.9	1.3	2.6	5		
						4	6	6.1	3.8	3.6	11		
						5	13	17.1	11.3	3.9	16	.0174	17.3
						6	50	65.8	83.1	5.0	23		
Bush Ramano	74	167	2	3.46	82	1	5	6.1	.6	1.9	3		
						2	2	2.4	1.3	-	5	.020	3.4
						3	2	2.4	1.9	-	9		
						4	4	4.9	3.1	3.6	13		
						5	13	15.9	13.1	4.2	17	.103	33.4
						6	56	68.3	83.8	4.7	24		

* % Fiber and % Seeds Determined on sizes 1-3 and 4-6

TABLE II - CANNED PRODUCT EVALUATION - 1972

Variety	Harvest	Sieve Size	% Seeds*	% Fiber*	USDA GRADE FACTORS					
					Liquor	Color	Absence of Defects	Character	TS	Grade
Greenpod 467	I	4-6	2.6	.017	9	14	35	35	93	A
	II	FR	7.2	.032	8	14	34	36	92	A
Greenpod 317	I	1-3	2.2	.015	10	13	35	38	96	A
		4-6	3.7	.015	10	11	35	36	92	A
	II		5.4	.033	9	12	33	36	90	A
Early Gallatin	I	1-3	1.4	.013	10	13	35	38	96	A
		4-6	3.2	.016	8	14	35	37	94	A
	II		7.5	.029	8	12	34	35	89	B
Greenpod 136	I	1-3	1.2	.013	10	14	34	38	96	A
		4-6	2.3	.024	9	13	34	38	94	A
	II		9.1	.026	8	13	35	34	90	B
Greenpod 68-115	I	1-3	1.4	.014	9	14	34	38	95	A
		4-6	2.3	.016	8	13	35	38	94	A
	II		3.5	.015	8	13	34	36	91	A
Tendercrop	I	1-3	2.0	.020	9	13	35	38	95	A
		4-6	3.2	.023	7	13	34	34	88	B
	II		7.2	.030	8	12	35	34	89	B
Bush Romano	I		9.5	.038	6	14	33	34	87	B
	II		25.5	.048	5	8	33	30	75	Subst.
Avalanche	I	1-3	2.4	.013	10	12	34	33	94	A
		4-6	6.4	.033	8	13	35	34	90	B
	II		9.5	.053	7	12	35	32	86	B
Sunbeam	I	1-3	3.3	.014	9	11	33	38	91	A
		4-6	11.4	.025	8	12	33	32	85	B
	II		20.3	.039	7	12	32	30	81	C

* % Fiber and % Seeds determined on sizes 1-3 and 4-6

TABLE III - FROZEN PRODUCT EVALUATION

Variety	Harvest	Sieve Size	% Seeds*	% Fiber*	USDA GRADE FACTORS			Total Score	Grade
					Color (20)	Absence of Defects (40)	Character (40)		
Greenpod 467	I	4-6	3.7	.021	16	38	36	90	B
	II	Mixed	6.6	.028	17	36	30	83	C
Greenpod 317	I	1-3	1.9	.013	19	40	39	98	A
		4-6	4.6	.016	15	38	35	88	C
	II	Mixed	8.5	.022	17	38	34	89	B
Early Gallatin	I	1-3	1.7	.021	19	40	39	98	A
		4-6	2.3	.020	18	38	34	90	B
	II	Mixed	8.3	.029	17	37	38	92	A
Greenpod 136	I	1-3	1.9	.017	--	--	--	--	-
		4-6	4.6	.013	20	40	38	98	A
	II	Mixed	8.5	.029	16	38	40	94	B
Greenpod 68-115	I	1-3	1.4	.019	20	40	40	100	A
		4-6	2.6	.018	20	40	38	98	A
	II	Mixed	3.8	.020	18	38	30	86	C
Tendercrop	I	1-3	1.4	.016	20	40	40	100	A
		4-6	3.5	.018	20	40	34	94	B
	II	Mixed	7.9	.026	16	38	30	84	C
Bush Romano	I	Mixed	11.8	.026	17	36	32	85	B
	II	Mixed	30.4	.031	18	39	30	87	C
Avalanche	I	1-3	2.5	.020	18	40	38	96	A
		4-6	4.6	.027	17	40	35	92	B
	II	Mixed	18.0	.069	15	38	34	87	C
Sunbeam	I	1-3	3.3	.017	14	40	40	94	C
		4-6	13.1	.025	16	38	40	94	B
	II	Mixed	24.8	.042	17	38	30	85	C

* % Fiber and % Seeds determined on sizes 1-3 and 4-6.

EVALUATION OF TOMATO CULTIVARS FOR PROCESSING

by

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Ruth Stillabower, and Stanley Z. Berry*

The 1972 processing tomato project included 13 cultivars of tomatoes which were grown in replicated plots under acceptable commercial practices at the Ohio Agricultutal Research and Development Center - Northwestern Branch, Hoytville, Ohio. Each cultivar was machine harvested (with FMC Western Model) and bulk handled in 400 pound lots, either dry, or in water containing 500 ppm chlorine dioxide. Following harvest, the tomatoes were transported by truck (approximately 100 miles) to the Food Processing Pilot Plant at The Ohio State University, Columbus, Ohio for processing. All lots were processed after 12 hours hold following harvest for peeled tomatoes, and after 24 hours for juice manufacture.

QUALITY EVALUATION

1. U. S. Grade was determined on a 25 pound sample by segregating tomatoes with No. 1's, No.2's for color, No. 2's for defects, and culls. Any tomatoes that were both No. 2 in defects and No. 2 for color were placed in the No. 2's for defect category.

2. Size was determined by counting the number of fruits in the 25 pound sample. In addition the tomatoes were subjectively classed for shape, core, and firmness.

3. 20 field run tomatoes were selected and used for objective quality evaluation. The sample was cut in half, quartered, extracted in Food Processing Equipment Co. Laboratory pulper, and deaerated.

   a. The sample was evaluated for color with the Hunter Color and Color Difference Meter using the wide area illuminator and large aperture. The instrument was standardized with the "Red" tile with L = 25.59, aL = 27.40, and bL = 12.54.

   b. Juice Color. Agtron F samples of raw or canned tomato juice were presented to the Agtron F instrument in a standard plastic sample cup. The instrument was standardized, using a black plastic plate (Monsanto Lustrex 11250) at 70. Readings were taken directly.

   c. Juice Color. Agtron E-5 samples of canned tomato juice were presented to Agtron E-5 instrument in a standard plastic sample cup. The instrument was calibrated at 48. Readings were taken directly and repeated as such.

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*Assistance of Professor E. K. Alban, Vegetable Crop; James Trotter and staff, Northwestern Branch OARDC: and the Processing and Technology assistants -- Martha Eshler, Gary Flinn, Jacquelyn Gould, Marshall Hill, Richard Houtzer, Jerry Pope, Jerry Shoup, and Jerry Wright.

d. Percent soluble solids. An Abbe refractometer was used for direct determinations of percent soluble solids and refractive indice on raw or canned juice. The instrument was standardized with distilled water and all readings converted to 20°C. No correction is made for salt.

e. Percent total acid as citric. The sample (raw or canned) used for pH determination was directly titrated using 0.1 normal sodium hydroxide solution to a pH of 8.1 Calculations using the following equation were made:

$$\% \text{ acid} = \frac{(\text{No. of Ml. of o.1 N NaOH})\ (.0064)}{10 \text{ ml. sample}} \times 100$$

f. pH. The pH was determined by the glass electrode method (Beckman Zeromatic pH meter) using 10 ml. of tomato juice (raw or canned) diluted with 90 ml. of distilled water.

g. Ascorbic Acid. Ten ml. aliquots of tomato juice were diluted with 90 ml. of 1% meta phophoric acid and filtered. A 10 ml. aliquot of the filtrate was titrated with o.2% 2,6-dichlorophenolindophenol indicator solution. Milligrams of vitamin C were determined by the following formula:

$$\text{Dye factor} \times \text{ml. of dye} \times 100 = \frac{\text{mgm. Vit. C}}{100\text{gms.}}$$

h. Viscosity. The viscosity was measured using the GOSUC efflux tube instrument containing a 5/64" opening and standardized at 32 seconds at 25°C. with water. The rate of flow from the instrument was measured with a stop watch and the readings were recorded directly in seconds.

4. Grades of Canned Tomatoes. The grade was determined in accordance with the U.S. Standards for Grades of Canned Tomatoes.

5. Grades of Canned Tomato Juice. The grade was determined in accordance with the U.S. Standards for Grades of Canned Tomato Juice.

PREPARATION AND PROCESSING

All tomatoes were prepared by washing, lye peeling (18% caustic soda and Fas-peel at 200°F. for 20 to 30 seconds), and processed as whole tomatoes or washed, chopped, hot broken at 190°F., extracted and plate pasteurized at 250°F. for 0.7 seconds, filled, closed and cooled in the OSU Pilot Plant. Each lot of whole tomatoes was filled to 10.5 - 11.0 ounces in No. 303 plain tin cans with a 30-grain salt (21 grains Sodium and 9 grains Calcium Chloride) added.

TABLE I - 1972 RAW PRODUCT TOMATO CULTIVAR EVALUATION

Average for all Harvests

Cultivar	Count/ 25 lb.	PERCENTAGE				SHAPE			CORE			Stemless %
		US No.1	US No.2C	US No.2D	Culls	Round	Pear	Inter-mediate	Small	Medium	Large	
C-28	98	61	26	6	7	X					X	0
Merit	156	68	20	7	5			X			X	95
Potomac	140	58	23	10	9		X		X			0
Red Rock	123	67	21	6	6	X				X		95
Ohio 28-71	118	63	25	6	6	X			X			5
Ohio 38-71	168	54	32	8	6			X	X			30
Ohio 24-70	111	55	31	6	8	X					X	0
Ohio 20-70	128	68	16	8	8	X					X	20
Ohio 30-71	120	57	33	5	5	X					X	10
Trimson	83	51	34	8	7	X					X	25
Chico III	208	62	27	6	5		X		X			90
Ohio 21-70	121	70	16	7	7			X			X	25
Ohio 19-70	105	69	15	8	8	X					X	0

TABLE II - RAW PRODUCT TOMATO CULTIVAR EVALUATION OBJECTIVE COLOR AND CHEMICAL ANALYSIS

Average for all Harvests

Cultivar	Hunterlab				% S.S.	% Citric	pH
	L	a	b	a/b			
C-28	33.7	32.5	14.8	2.19	5.6	.42	4.45
Merit	33.2	34.5	15.1	2.28	4.3	.26	4.61
Potomac	33.6	33.4	14.4	2.31	4.1	.26	4.60
Red Rock	31.0	37.1	13.5	2.73	5.1	.36	4.51
Ohio 28-71	32.5	31.5	14.8	2.12	4.8	.38	4.53
Ohio 38-71	33.7	30.8	13.8	2.23	5.3	.33	4.55
Ohio 24-70	31.3	36.3	13.9	2.62	4.7	.32	4.55
Ohio 20-70	32.1	37.4	14.1	2.65	5.2	.35	4.65
Ohio 30-71	32.9	30.7	14.7	2.42	4.5	.35	4.53
Trimson	29.1	35.2	11.6	2.60	5.1	.36	4.60
Chico III	27.2	32.1	12.2	2.61	4.7	.29	4.70
Ohio 21-70	32.5	32.2	13.6	2.36	4.4	.37	4.50
Ohio 19-70	29.2	34.5	12.5	2.76	5.4	.35	4.55

TABLE III - 1972 TOMATO CULTIVAR EVALUATION AND OBJECTIVE EVALUATION OF WHOLE TOMATOES

Cultivar	Drained Weight (20)	Wholeness (20)	Color (30)	Defects (30)	T.S.	Grade	pH	% TA	% S.S.
C-28	17.0	19.5	26.0	30	92.5	B	4.61	.28	5.35
Merit	17.5	18.5	28.0	29	93	A	4.75	.24	4.8
Potomac	18.5	19.0	24.0	30	91.5	B	4.8	.20	4.8
Red Rock	15.8	18.8	24.8	30	89.4	B	4.66	.25	5.05
Ohio 28-71	17.2	18.2	26.5	30	92	B	4.75	.24	4.95
Ohio 38-71	18.6	18.5	26.0	22	86	C	4.68	.26	5.1
Ohio 24-70	18.5	18.5	26.0	30	93	B	4.70	.25	5.2
Ohio 20-70	16.2	18.8	26.5	30	91.5	B	4.65	.27	4.7
Ohio 30-71	17.5	19.0	25.2	30	91.2	B	4.70	.21	4.95
Trimson	15.0	18.0	27.0	30	90	C	4.65	.25	5.2
Chico III	16.5	18.0	25.2	30	93	B	4.65	.23	5.1
Ohio 21-70	16.0	17.5	23.6	30	86.3	B	4.62	.27	4.8
Ohio 19-70	17.0	18.7	27.0	29	91.3	A	4.80	.23	5.35

TABLE IV - 1972 TOMATO JUICE EVALUATION - OBJECTIVE QUALITY AND CHEMICAL ANALYSIS

	Cultivar												
	C-28	Merit	Poto-mac	Red Rock	Ohio 28-71	Ohio 38-70	Ohio 24-70	Ohio 20-70	Ohio 30-71	Trim-son	Chico III	Ohio 21-70	Ohio 19-70
Vacuum	9	8	8	8.5	8.5	10	9	10	10	10	10	8.6	10
Color (20)	27.5	29.5	26.5	27.5	29	30	28	28	28	28	29	27.5	28.5
Consistency (15)	14	15	13	15	15	15	15	15	15	15	15	15	15
Defects (15)	15	15	15	15	15	15	15	15	15	15	15	15	15
Flavor (40)	38	38	37	35.5	38	38	38	38	38	38	37.5	36	38
T.S.	93.5	97.5	88.5	93	96.5	98	96	96	96	96	96.5	93.5	96.5
Grade	A	A	A	A	A	A	A	A	A	A	A	A	A
Viscosity	42.5	48.5	41.8	49.1	46.25	39.0	41.1	38.6	47.0	39.2	53.75	42.4	44.0
pH	4.41	4.56	4.50	4.50	4.50	4.48	4.45	4.65	4.42	4.55	4.50	4.65	4.50
% TA	.35	.30	.28	.38	.31	.35	.36	.28	.32	.28	.32	.36	.32
% SS	5.9	5.5	4.8	6.0	5.35	5.9	5.6	5.2	5.4	5.3	5.5	5.4	6.0
Agtron F	35.25	37.25	31.75	39.0	36.5	34.0	36.0	33.0	33.0	33.6	32.25	36.25	33.0
Agtron E-5	30.9	31.25	30.5	30.75	30.5	30.0	31.25	28.0	28.5	29.75	28.5	29.5	28.75
Hunterlab L	26.15	25.15	24.92	26.45	25.6	25.6	24.25	23.7	26.1	25.6	24.65	25.45	25.95
a	25.9	21.1	17.62	28.1	24.35	27.9	19.15	24.5	28.5	26.05	24.65	25.6	25.95
b	12.7	12.4	8.8	14.15	12.8	13.8	11.7	12.9	13.7	12.35	12.15	12.8	13.15
a/b	2.04	1.70	2.00	1.98	1.90	2.02	1.63	1.90	2.08	2.10	2.03	2.00	2.14
Ascorbic Acid	20.4	15.5	14.2	20.95	20.45	16.8	19.9	24.00	19.84	17.00	20.22	20.35	23.7

COMMERCIAL TOMATO CULTIVAR EVALUATION

by

Wilbur A. Gould, Jerry Wright,
and in cooperation with Stanley
Berry, Marion White, Tip Top Canning Co.,
Beckman and Gast Company and Hirzel Canning Co.

During the 1972 season, three new OARDC cultivars were grown and processed by three cooperating Ohio tomato processors. The report on the field production practice has been reported elsewhere.

All 3 processors had similar production lines, using hand coring, caustic peeling, and continuous cookers. Similarities and general differences are noted in Table I. The major differences were that Processor 1 canned 60 to 75% of the lots as peeled tomatoes. Further they acid dipped the tomatoes immediately after hand trimming. Processor 2 canned nearly 100% of each lot directly from the line and machine filled. Processor 3 selected about 25-30% from the peeling line for the canned tomatoes.

The data in Table II summarizes the raw product quality using objective methods for evaluating product quality, that is, Agtron E-5 and Hunter Tomato Colorimeter (D6), pH, titratable acid and soluble solids. Differences and similarities are noted in the Table for the cooperating processors by cultivars. The maturity evaluation of the tomatoes from cooperator 2 would indicate that they were somewhat less mature for all cultivars when compared to the other two cooperators. Cultivar Line 3 was more mature than the other three lines used in the study.

The data in Table III summarizes the Grades of the canned products as evaluated in accordance with the U. S. Standards for Grades for Tomatoes, and by objective methods for pH, titratable acid and soluble solids. Line 3 scored the highest for the drained weight attribute of quality for all three cooperators. Generally all lines were scored in the Grade B category for color with exceptions noted for Line 2 by cooperators 1 and 2 and C-28 for cooperators 2 and 3.

For comparison purposes in evaluating the commercial samples, data in Table III includes similar evaluation for canned samples processed from the same cultivars grown at the Northwestern Branch of OARDC at Hoytville and processed in the OSU Pilot Plant at Columbus. Generally, all the samples performed reasonably similar as to canned product quality when cmparing the OSU samples to the commercial samples. Exceptions are noted for better color scores on Line 1 at OSU and poorer color score for the OSU lot from Line 2.

Summarizing these studies, one can conclude that High Extra Standard to Low Fancy quality canned tomatoes were processed from three new cultivars when grown and processed under commercial conditions. Data from the OSU pilot plant samples would indicate that similar quality was processed from the same cultivars. One significant difference was noted among the cooperators and the OSU samples in that a much higher pH and lower total acid was found for all the OSUsamples. For these OSU samples no acidification of the canned samples were made nor were they washed with acid after peeling in the OSU lines. It is believed that this difference can be attributed to the high alkaline content of the OSU water used in the washing of the peeled tomatoes.

TABLE I - UNIT OPERATION AND PARAMETERS USED BY COOPERATORS

	Cooperators		
Unit Operation	1	2	3
Harvest - Hand	Yes	Yes	Yes
Bulk Handled	Yes	No	Yes
Water Unload	Yes	No	Yes
Flume	Yes	Yes	Yes
Caustic	16% @ 218°	18% @ 220°	17% @ 215°
Core	Hand - Spoon	Hand - Knife	Hand - Spoon
Trim	Hand	Hand	Hand
Fill	Hand	Machine	Hand
Sterilize	Continuous Agitate	Continuous Agitate	Continuous Non-Agitate

TABLE II - RAW PRODUCT EVALUATION

Cultivar I (OARDC 19-70)

Cooperator	E5 Cut	E5 Pulp	D6	pH	TA	SS
1	--	--	--	--	--	--
2	36.8	38	60.5	4.2	.365	--
3	36.9	23	73.6	4.6	.21	5.6
$\bar{x}$	36.8	30.5	67.5	4.4	.281	5.6

Cultivar II (OARDC 21-70)

1	--	--	--	--	--	--
2	34.5	35	60.4	4.5	.31	--
3	38.8	21.5	73.8	4.8	.28	5.3
$\bar{x}$	36.7	28.3	67.1	4.65	.30	5.3

Cultivar III (OARDC 24-70)

1	39.3	23	75.8	4.2	.42	--
2	34.4	36	60.9	4.3	.45	--
3	36.7	21	73.7	4.4	.32	5.0
$\bar{x}$	36.8	27	70.3	4.3	.39	5.0

Cultivar IV - C-28

1	41.9	27	67.3	4.3	.38	--
2	32.0	36	59.9	4.65	.36	--
3	40.2	25	68.8	4.2	.42	5.5
$\bar{x}$	34.7	29	65.3	4.35	.39	5.5

TABLE III - QUALITY EVALUATION OF CANNED TOMATOES

		U.S.D.A. Scores								
	Cooperators	Drained Weight (20)	Whole-ness (20)	Color (30)	Defects (30)	T.S.	Grade	pH	% TA	% SS
OARDC	OSU	16.0	18.3	27.3	30	91.6	A	4.72	.248	5.1
(19-70)	1	16.0	17.5	26.5	29.5	89.5	B	4.27	.41	6.0
Line I	2	17.5	16.7	26.6	30	90.8	B	4.45	.35	6.7
	3	16.5	19.7	26.3	29	91.5	B	4.35	.34	6.0
	$\bar{x}$	16.5	18.1	26.7	30	91.3	B	4.45	.34	5.95
OARDC	OSU	16.0	17.9	24.3	30	88.2	B	4.61	.268	4.8
(21-70)	1	16.5	18.6	27.0	30	92.1	A	4.35	.36	6.0
Line II	2	15.8	16.8	27.0	30	89.6	A	4.48	.32	6.3
	3	17.7	19.6	25.5	30	93.1	B	4.31	.32	5.7
	$\bar{x}$	16.5	18.2	26.0	30	90.7	B	4.44	.317	5.7
OARDC	OSU	18.0	18.6	26.3	30	92.9	B	4.71	.245	5.1
(24-70)	1	18.8	16.8	25.3	30	90.9	B	4.30	.39	5.9
Line III	2	20.0	15.5	26.8	30	92.3	B	4.45	.33	6.0
	3	17.0	18.8	26.0	30	91.8	B	4.31	.30	5.7
	$\bar{x}$	18.5	17.4	26.1	30	92.0	B	4.44	.32	5.68
C-28	OSU	17.0	19.6	26.4	30	93.0	B	4.58	.30	5.5
Line IV	1	16.8	17.3	25.6	30	89.7	B	4.30	.39	5.8
	2	16.5	16.0	28.6	30	91.1	A	4.44	.35	6.4
	3	17.0	19.3	27.0	30	93.3	A	4.30	.41	5.8
	$\bar{x}$	16.8	18.1	26.9	30	91.8	B	4.41	.36	5.88

RELATIONSHIP OF USDA D6 TOMATO COLORIMETER TO AGTRON E-5

by

Wilbur A. Gould and Jerry Wright

The U.S. Department of Agriculture developed the Hunter D6 tomato colorimeter (TCM) to evaluate the color of raw tomato pulp. The instrument is now used in the evaluation of tomato quality as defined in the new U.S. Standards for Grades of Tomatoes for Processing. A limit of 63 or better is specified for acceptance of tomatoes.

The Magnuson Engineers, San Jose, California, developed the AGTRON E5 for use in the grading of tomatoes for processing by the California Department of Agriculture.

This study was conducted to ascertain the relationship of the two instruments, and their relationship to former grade evaluation of tomatoes for processing.

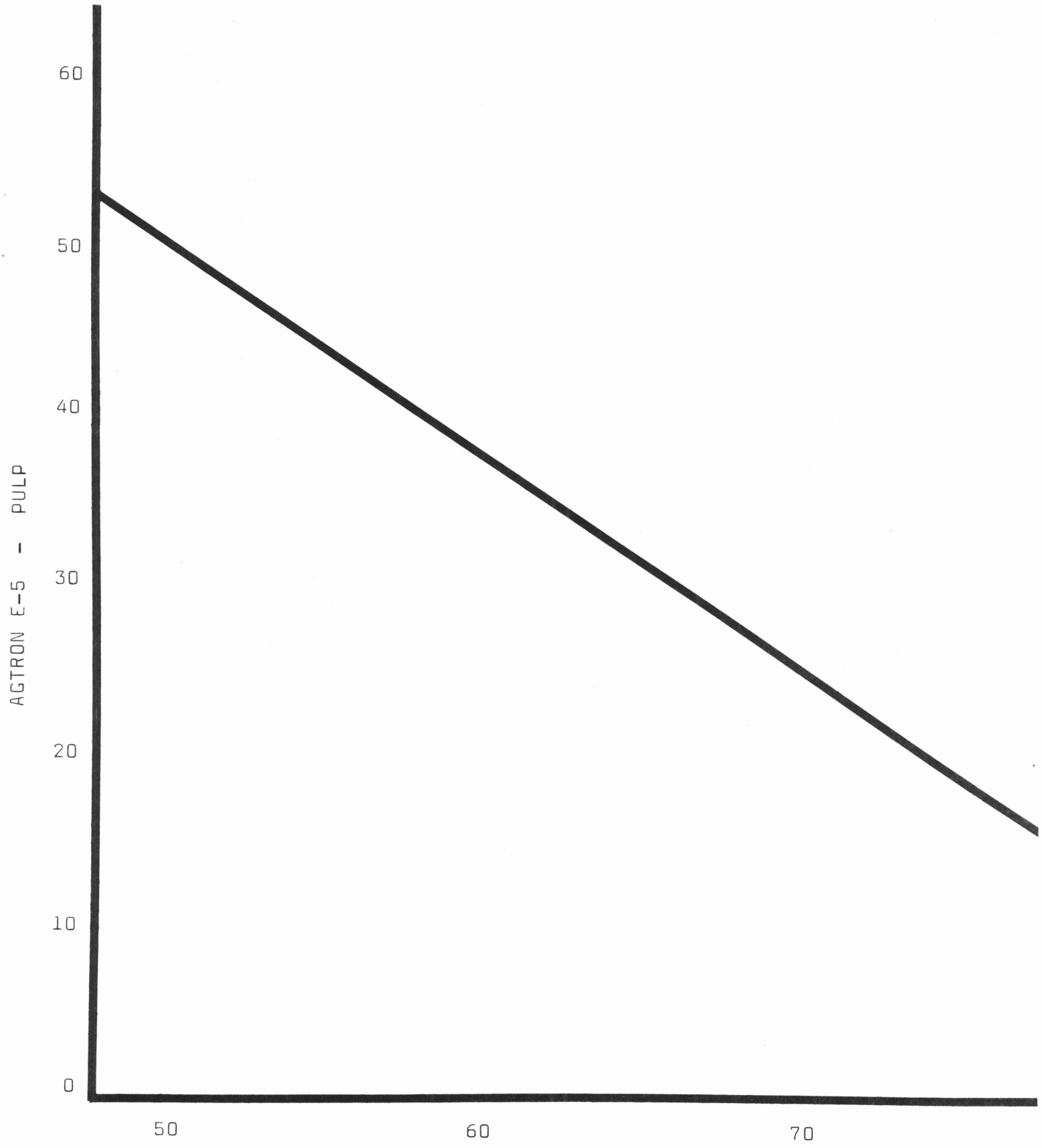
Table I was obtained by selecting representative samples from a USDA Graders table after he had segregated tomatoes into High No. 1's, Low No. 1's, High No. 2's, and Low No. 2's for color only. The tomatoes were cut in half and evaluated for their cut-surface color on the AGTRON E-5; then extracted, deaerated, and evaluated for color with both color instruments and for pH and titratable acidity. These data would indicate that a 63 color score on the TCM D6 colorimeter would be close to the former 90% red line used to distinguish between No. 1's and No.2's on the former tomato grades. Furthermore a 35 on the AGTRON E-5 corresponds to a 63 on the TCM. During the 1972 season, further data was collected by taking samples from several areas in the state to relate the two color instruments. The relationship in terms of a color line is shown in Chart I for the TCM D6 versus the AGTRON E-5. In Chart II, the AGTRON E-5 relationship is shown for the cut surface color versus the pulp color for several lots of tomatoes sampled and evaluated as above. From these data and using the USDA TCM index of 63, we find it to be equivalent to the E-5 value of 35 for pulp color. A 35 pulp color is equivalent to a 36 of the cut surface of the tomatoes for the AGTRON E-5. (We would expect these relationships to be different depending on the internal color of tomatoes). Higher values represent good red tomato color (No. 1's on the TCM D6) and, conversely, lower values represent poor red tomato color (No. 2's or lower). With the AGTRON E-5, values greater than 35 or 36 represent better tomato red color. Pending further studies, we have tentatively established values below 30 on the D6 as Culls for color and values greater than 72 on the AGTRON E-5 for the cut surface and greater than 86 on the AGTRON E-5 for the pulp color as Culls for color.

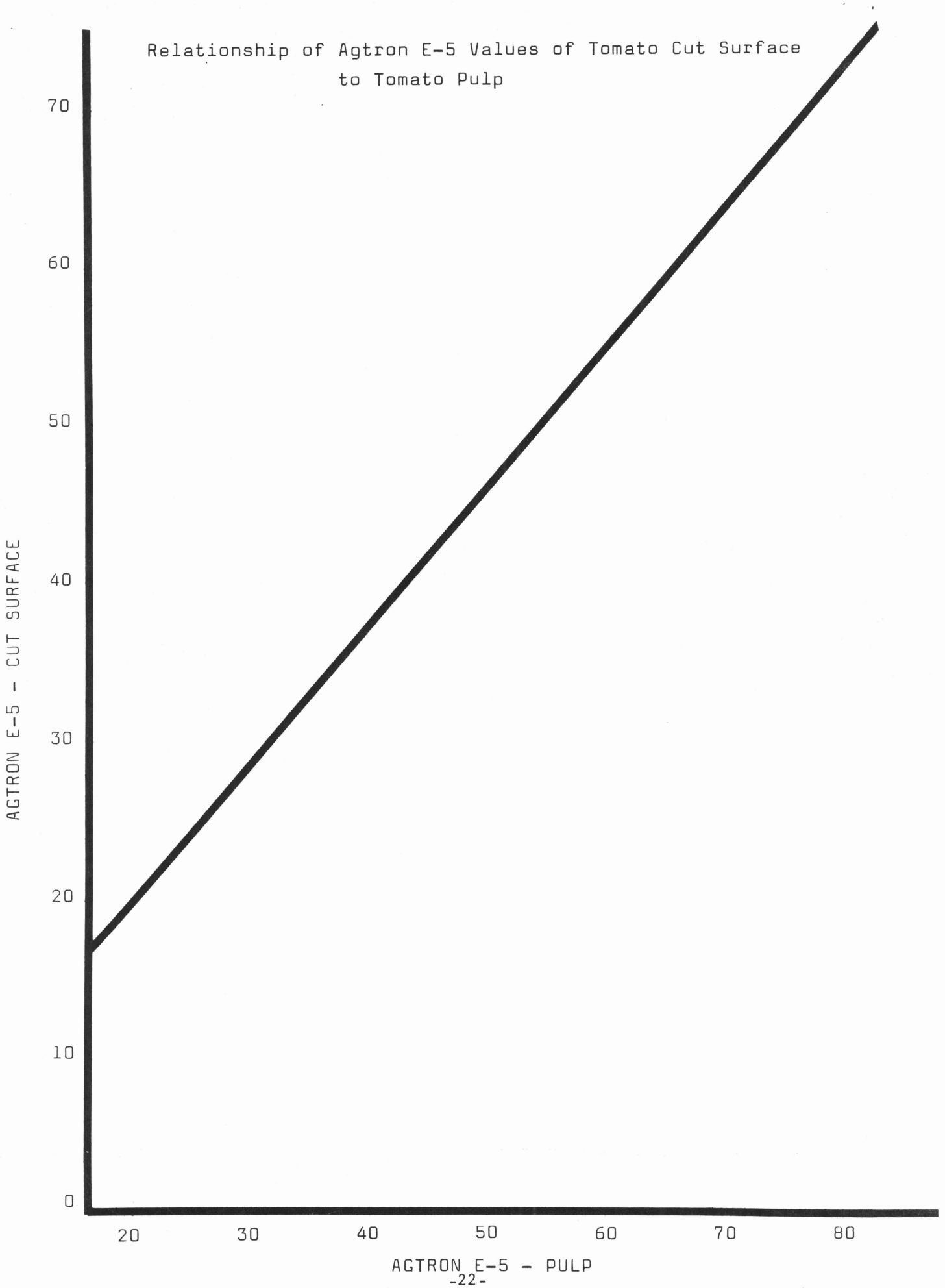
The AGTRON E-5 has the advantage over the Hunter Tomato Colorimeter in that color can be determined on an individual tomato, that is, cut surface as well as the pulped color.

TABLE I - EVALUATION OF RAW PRODUCT TOMATO COLOR

Grade	Agtron E5		TCM D6		
	Cut	Pulp	Pulp	pH	T.A.
High No. 1's	32	29	91.2	4.8	0.29
Low No. 1's	40	29	67.5	4.5	0.33
High No. 2's	51	46	51.9	4.6	0.31
Low No. 2's	71	86	30.2	4.3	0.38

Relationship of Agtron E-5 to Hunter D 6 for Tomato Pulp




Relationship of Agtron E-5 Values of Tomato Cut Surface to Tomato Pulp
AGTRON E-5 - CUT SURFACE
0
10
20
30
40
50
60
70
20
30
40
50
60
70
80
AGTRON E-5 - PULP

EFFECTS OF FOOD ADDITIVES ON THE QUALITY OF CANNED TOMATOES

by

Wilbur A. Gould, Jacquelyn Gould, and James Black

A study using thirteen cultivars was undertaken to show the effects of food additives on quality of canned tomatoes. In this study, thirteen cultivars were machine harvested, bulk handled in water plus 500 ppm chlorine dioxide, and in dry bulk boxes. They were hauled from Hoytville to Columbus, approximately 100 miles, and held 12 hours following harvest prior to canning.

The tomatoes were washed, lye peeled (18% caustic soda and Faspeel at 200°F. for 20 seconds), rinsed in water, acid dipped (1% citric acid), and trimmed if necessary. The tomatoes were filled into cans containing 2 ounces of tomato juice, and with the FMC hand packed filler, 10-10½ ozs. of tomatoes were packed into the cans. Thirteen lots were packed as shown in Table I.

The filled tomatoes were exhausted in an A. K. Robins steam exhaust box for 4 minutes, steam flow closed (17 psi) with a 006 American Can Co.closing machine, and still retort processed for 20 minutes at 1-2 psi free flowing steam. They were water cooled for 20 minutes and warehoused for three months at room temperature prior to grading according to the U. S. Standard for Grades of Canned Tomatoes.

The additive had little or no effect on grade quality; however, the pH was lowered and the titratable acid was increased on the lots canned with the citric acid addition. Soluble solids were increased on all acidified packs, although no explanation can be given for packs wherein sugar was not present in the salt tablet.

Although no spoilage resulted in the non-acidified packs, it is highly recommended that at least the 50 grain salt tablet be formulated with 20% citric acid to adjust the pH to a safe value, that is, somewhat less than 4.5 and a titratable acidity of 0.35 or above. Ideally a 50 grain salt tablet should contain 30% citric acid and for these cultivars and processing parpameters, the pH would be in a safe range of 4.30 to 4.35 and a titratable acid value of 0.40 to 0.45. Obviously, these tablets might have to have more or less citric acid added if using cultivars out of the range as used in these studies or if processing conditions are changed.

TABLE I - FOOD ADDITIVES FOR CANNED WHOLE TOMATOES

	Treatment					
	1	2	3	4	5	6
Replicates	13	13	13	13	13	13
SALT TABLET						
% of Food Additives						
NaCl	80	85	62	60	44.50	42.50
$CaCl_2$	20	15	15	15	15	15
Citric Acid	--	--	19.50	19.50	37	37
Sugar	--	--	--	2	--	2
Na Bicarbonate	--	--	3.50	3.50	3.50	--
Size grain/can	25	30	50	50	50	50
Drained Weight (20)	17.00	17.59	17.10	17.30	17.10	18.00
Wholeness (20)	18.50	18.85	18.53	18.36	18.35	18.19
Color (30)	25.00	25.90	25.30	24.44	24.90	24.86
Absence of Defects (30)	29.20	29.60	29.50	29.30	29.60	29.60
Total Score	90.80	92.50	90.70	90.35	90.40	90.30
Grade	B	B	B	B	B	B
pH	4.69	4.64	4.47	4.47	4.22	4.26
T.A.	.24	.27	.36	.35	.48	.47
S.S.	5.00	5.00	5.20	5.32	5.25	5.24

EFFECTS OF FOOD ADDITIVES ON THE QUALITY OF CANNED TOMATO JUICE

by

Wilbur A. Could, Ruth Stillabower, Jacquelyn Gould and James Black

A study using thirteen cultivars was undertaken to show the effects of food additives on quality of canned tomato juice. In this study the cultivars were grown and harvested at the Ohio Agricultural Research and Development Center - Northwestern Branch, Hoytville, Ohio and transported in water to the Ohio State University Food Processing Pilot Plant in Columbus. The tomatoes were washed, chopped, hot extracted at 190°F., and pasteurized at 250°F. for 0.7 minutes. The juice was then filled into No. 303 fruit enameled lined cans and an additive in tablet form as shown in Table I was added. The can was then sealed, coded, held for three minutes and cooled to 100°F.

The additives had little or no effect on total scores or grade. The lots containing the citric acid additive had lower pH's while the total titratable acid increased. The lots containing the sugar additive had a significant increase in soluble solids.

Additives 10, 11, and 13 are the most desirable in that a total titratable acid of at least .35 and a pH of 4.5 or lower was attained. If a sweeter juice is preferred Number 13 additive is the most desirable.

TABLE I - FOOD ADDITIVES IN TOMATO JUICE

	Additives						
	7	8	9	10	11	12	13
Replicates	24	22	21	20	19	18	17
Vacuum	9.85	9.30	9.00	9.20	9.45	9.62	9.50
SALT TABLET							
% of Food Additives							
NaCl	100	95	93	90	75	18	17
Citric Acid	--	--	--	--	16.7	--	3.7
Ascorbic Acid	--	5	7	10	8.3	1.9	1.85
Sugar	--	--	--	--	--	80.07	77.45
Grain size/can	50	50	50	50	60	130	135
U.S.D.A. GRADES							
Color (30)	28.23	28.00	28.00	28.00	27.70	28.00	28.40
Consistency (15)	14.92	14.85	14.90	14.90	14.79	14.87	14.91
Absence of Defects (15)	15.00	14.92	15.00	15.00	15.00	15.00	15.00
Flavor (40)	37.20	37.50	37.30	36.90	36.79	37.75	37.50
Total Score	95.2	95.2	95.0	94.7	94.0	95.7	95.8
Grade	A	A	A	A	A	A	A
Viscosity	44.10	43.40	43.79	44.60	46.10	45.30	45.40
pH	4.50	4.46	4.45	4.41	4.20	4.46	4.32
T.A.	.32	.34	.34	.35	.47	.34	.41
S.S.	5.53	5.50	5.45	5.50	5.60	6.40	6.50
Agtron F	31.90	34.40	34.50	33.70	35.19	34.78	34.90
Agtron E5	29.86	30.20	30.20	30.00	30.00	30.10	30.10
Hunterlab L	25.37	25.00	25.10	25.40	25.60	25.60	25.50
a	24.72	24.10	24.90	24.90	25.00	24.30	24.70
b	12.60	12.50	12.60	12.70	12.87	12.60	12.60
a/b	1.96	1.93	1.98	1.96	1.94	1.92	1.96
Ascorbic Acid	19.66	49.00	63.00	81.19	78.46	52.30	52.50

RETENTION OF ASCORBIC ACID IN FORTIFIED TOMATO JUICE

by

Gerald G. Pope and Wilbur A. Gould

INTRODUCTION

Tomato juice is an important source of ascorbic acid and the retention of this vitamin during storage has been carefully investigated. Fortification with ascorbic acid has not been permitted under the current Tomato Juice Standard of Identity. However special packs of tomato juice have been processed with added ascorbic acid under the USDA Needy Families Program. If these packs are to fulfill their intended purpose of increasing ascorbic acid levels in the diets of these families it is necessary to know the effect of adding ascorbic acid to tomato juice on the retention of this vitamin during storage. This study was conducted to determine the shelf-life of ascorbic acid in fortified tomato juice and to determine a prediction formula for its retention

MATERIALS AND METHODS

Five tomato cultivars were grown and harvested at the Ohio Agricultural Research and Development Center - Northwestern Branch, Hoytville, Ohio and transported in water to the Ohio State University Food Processing Pilot Plant in Columbus Ohio. The tomatoes were washed, chopped, preheated to 190° F and extracted through a 0.023 inch screen. The juice was flash pasteurized at 250° F and filled hot. To each lot of juice was added a solution of ascorbic acid in tomato juice drawn from the filler bowl calculated to increase the ascorbic acid concentration by 0, 12, 24, 36, or 48 mg./100 ml. The juice was filled into No. 303 fruit enamel lined cans and a 30 grain sodium chloride tablet added. The cans were sealed, coded, cooled to 100° F and placed in storage at 35, 55, 63, 83, and 103° F.

Two random samples from each fortification level in each lot were taken after cooling and prior to storage and after three, six and nine months storage. Ascorbic acid was measured by titration with a standard 2,6 - dichloroindophenol dye solution (AOAC). Percent ascorbic acid retained was calculated for each sample. A factorial analysis was used to determine the effect of time, temperature and fortification level on the percent retention.

RESULTS AND DISCUSSION

Five distinct fortification levels were achieved and designated 0, 12, 24, 36, and 48. The average initial ascorbic acid concentration and the range over the five cultivars for each level were: level 0 (no fortification), 16.6 mg./100 ml. (15.5 - 17.0); level 12, 28.4 mg./100 ml. (24.2 - 32.2); level 24, 41.1 mg./100 ml. (38.0 - 46.0); level 36, 54.0 mg./100 ml. (50.0 - 55.2);

RESULTS AND DISCUSSION (continued)

and level 48, 72.5 mg./100 ml. (70.0 - 76.5).

Each of the factors, time, temperature of storage and fortification level significantly altered the percent ascorbic acid retained (P = .05).

Ascorbic acid concentration decreased in each fortification level and storage temperature at a constant rate during the nine months storage. The observed rates of loss of ascorbic acid in milligrams lost per month are shown in TABLE I.

Plotting the rate of loss versus temperature of storage and initial ascorbic acid concentration revealed logarithmic relationships. As either temperature or initial concentration were increased retention decreased. Highest percent retention was observed in refrigerated juice, 35 and 55° F, with no fortification and the lowest retention in juice with the highest ascorbic acid concentration held at elevated temperatures 88 and 108° F.

Prediction of retention of ascorbic acid

The loss of ascorbic acid from anaerobic food systems has been shown to follow first order kinetics and may be expressed as a rate constant, k, equal to $\frac{1}{t} \ln \frac{C}{C_o}$ where C_o is the initial concentration C is the final concentration and t the time of storage in months at a given temperature (Manninger). Rate constants were calculated from the data in this study and found to be constant within each storage temperature over all fortification levels. At 35° F k=0.0024, at 55° F 0.0112, and 63° F 0.040, and at 88° F 0.228. It was observed the rate constant for storage at fluctuating temperatures could be determined by average from the equation:

$$\frac{ak_1 + bk_2 + ck_3 + \ldots = ik_n}{a + b + c + \ldots + i} = k_{average}$$

where,

a = months at storage temperature 1,
b = months at storage temperature 2, etc. and
k_1 = rate constant at temperature 1,
k_2 = rate constant at temperature 2, etc.

It is clear from the data that the effect of temperature is logarithmic. Juice held at 108° F had to be discarded after six months due to loss of can vacuum and destruction of the juice integrety. Juice held at 88° F also had decreased vacuums after six and nine months of storage and browning of the juice could be noticed in the higher fortification levels.

In no cans were headspaces above 3/32 inch. No microbial contamination occured and detinning was not evident. Loss of vacuums at higher temperatures was attributed to formation of CO_2 from the destruction of ascorbic acid.

The increase in rate of loss of ascorbic acid has been reported to be expressed by the Arrhenius equation. The data from this study however did not fit satisfactorily this model. The rate of loss did not change smoothly with temperature and the alteration due to temperature was not exactly parallel in each fortification level. Other factors acting in fortified tomato juice may have altered the data collected from exact adherence to this equation. More specific prediction formula for fortified tomato juice would be useful. Rearranging the equation for the rate constant k yields:

$$\ln \frac{C}{C} = -kt \qquad (1).$$

Changing to base 10,

$$2.3 \log_{10} \frac{C}{C_o} = -kt \qquad (2).$$

and

$$2.3 \log_{10} \frac{C_o}{C} = kt \qquad (3).$$

From equation (3),

$$\frac{C_o}{C} = 10^{\frac{kt}{2.3}} \qquad (4).$$

and

$$C_o = C \cdot 10^{\frac{kt}{2.3}} \qquad (5).$$

From equation (2),

$$\frac{C}{C_o} = 10^{\frac{-kt}{2.3}} \qquad (6).$$

and

$$C = C_o \cdot 10^{\frac{-kt}{2.3}} \qquad (7).$$

The initial concentration C_o, after processing and cooling before storage necessary to produce a final concentration, C, may be predicted from equation (5) if the storage temperature and time are known. Similarly the final concentration C may be predicted from equation (7).

Values for C_o have been calculated from the data developed in this study and appear in TABLE 2.

From this table a tomato juice processor may determine the necessary initial concentration to produce a desired final concentration if the length of storage and storage temperature are known.

SUMMARY

A study of the effect adding ascorbic acid to tomato juice had on its retention was conducted. It was found tomato juice can be a successful carrier of added ascorbic acid if proper storage conditions are met. Retention was found to decrease with time directly and with temperature and fortification level logarithmically. The final concentration of ascorbic acid in fortified tomato juice was shown to be predicted by the formula:

$$C = C_o \cdot 10^{\frac{-kt}{2.3}}$$

with temperature constant. The rate constant K was determined for temperatures from 35° F to 88° F.

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TABLE I

EFFECT OF ADDED ASCORBIC ACID AND STORAGE TIME
ON PERCENT TOTAL ACID IN TOMATO JUICE

Ascorbic Acid Concentration mg/100ml	Storage Time (months)		
	3	6	9
	percent total acid in juice		
16.6 (no fortification)	0.382	0.373	0.445
28.4	0.386	0.382	0.448
41.1	0.389	0.384	0.449
54.0	0.392	0.395	0.452
72.5	0.395	0.392	0.456

TABLE 2

INITIAL ASCORBIC ACID CONCENTRATIONS, C_o, NECESSARY TO PRODUCE FINAL CONCENTRATIONS, C.

Time (Months)	Temperature (°F)	Final Ascorbic Acid Concentration Desired (mg/100ml)				
		30	40	50	60	70
		Initial Ascorbic Acid Concentration (mg/100ml)				
3	35	30.3	40.4	50.4	60.3	70.8
3	55	30.9	41.3	51.9	62.2	72.2
3	68	33.0	45.2	56.3	67.4	79.0
3	88	59.1	79.0	99.5	119.1	138.0
6	35	30.6	40.5	50.9	60.9	70.8
6	55	32.1	42.9	53.5	64.1	73.7
6	68	38.1	50.9	63.4	75.9	88.2
6	88	120.0	158.1	196.4	235.1	270.4
9	35	30.6	40.9	50.9	61.6	71.5
9	55	33.1	44.3	55.1	66.7	77.5
9	68	42.9	57.4	71.5	85.6	100.5
9	88	232.8	314.0	400.7	468.7	544.6

EFFECT OF STORAGE TIME AND TEMPERATURE AND ADDED ASCORBIC ACID ON THE TOTAL ACID AND pH OF TOMATO JUICE

by

Gerald G. Pope and Wilbur A. Gould

MATERIALS AND METHODS

Tomato juice was manufactured from eight tomato cultivars grown at the Ohio Agricultural Research and Development Center - Northwestern Branch, Hoytville, Ohio at the Ohio State University Food Processing Pilot Plant, Columbus, Ohio. Six of the cultivars were harvested twice giving a total of fourteen tomato juice lots. Each lot of juice was washed, chopped, preheated to 190°F. and extracted through a 0.023 inch screen. The juice was flash pasteurized at 250°F. and filled hot. Each lot of juice was divided into five fortification levels by adding solutions of ascorbic acid dissolved in tomato juice drawn from the filler bowl calculated to increase the ascorbic acid concentration by 0, 12, 24, 36, or 48 mg/100ml. The juice was filled into No. 303 fruit enamel lined cans and a 30 grain salt tablet added. The cans were sealed, coded, held for three minutes prior to cooling to 100°F. The canned juice was stored at 35, 55, 68, 88, or 108° F.

Two random samples from each fortification level in each lot were taken after cooling and prior to storage and at three month intervals. Ascorbic acid concentration was measured by titration with a standard 2,6 - dichloroindophenol dye solution (AOAC). Total acid was determined by titration of a 10 milliliter sample, diluted to 100 milliliters with distilled water, with 0.100 N NaOH with the end point determined at pH 8.1. Since the concentration of ascorbic acid was measured in each can the per cent total acid was calculated from the equation:

per cent total acid = per cent ascorbic + per cent citric

Per cent ascorbic was apparent from direct measurement. Per cent Citric was determined by the formula:

$$\text{per cent citric} = 100\ \frac{(\text{ml 0.100 N NaOH for total sample} - \text{ml 0.100 N NaOH for ascorbic})\ (.064)}{10\ \text{ml sample}}$$

The ml 0.100 N NaOH consumed by hydrogen ions released from the added ascorbic acid was calculated from the formula:

$$\frac{\text{per cent ascorbic (10 ml sample)}}{(0.176)\ (100)} = \text{ml 0.100 N NaOH for ascorbic acid}$$

RESULTS AND DISCUSSION

Factorial analysis of the 28 observations at each temperature of storage, fortification level and three month interval showed total acid was significantly altered ($P = .01$) by ascorbic acid fortification and length of storage. Juice pH was significantly altered by temperature of storage ($P = .05$) length of storage ($P = .01$) and a temperature time interaction ($P = .01$). Ascorbic acid addition did not change juice pH nor did storage temperature alter the per cent total acid.

Ascorbic acid reacts as a monobasic acid with a pk_a in water of 4.5. When added to tomato juice with an initial pH of near 4.50 no observable change occured in juice pH.

As can be seen from the data in Table 1 the observed per cent total acid increased with added ascorbic acid and time. The increase in total acid ascorbic acid is small and results from the partial ionization of ascorbic acid.

The length of storage was the only factor which alter both pH and total acid. Change in total acid is not consistant over time but decreased after six months and increased at nine months storage. The juice pH however decreased directly with length of storage as shown in Table 2.

Temperature of storage did not consistantly effect juice pHor per cent total acid. No difference in total acid could be observed between juice of the same cultivar and fortification level held a temperatures from 35° to 108°F. Juice pH did however decrease slightly with juice held at the higher temperatures for nine months. An interaction between storage time and temperature produced most pH decrease in juice held for nine months at 88 and 108° F.

SUMMARY

A shelf-life study of tomato juice fortified with ascorbic acid was conducted to determine the effect of adding ascorbic acid would have on juice pH and total acid. It was observed that total acid increased with ascorbic acid addition in direct relationship to the ionization of the added ascorbic acid. Little no alteration in juice pH occured in the fortified juice.

Temperatue of storage however and more significantly the length of storage altered juice pH and total acid. Total acid increased with storage time and pH decreased. A Time temperature interaction produced most rapid pH decrease after nine months at high storage temperatures.

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TABLE I

RATE OF LOSS OF ASCORBIC ACID IN FORTIFIED TOMATO JUICE

Initial ascorbic acid concentration mg./100ml.	Storage Temperature (°F)				
	35	55	68	88	108
	mg. ascorbic acid lost per month				
16.6	.11	.11	.23	.72	1.8
28.4	.16	.30	.71	.88	2.9
41.1	.60	.77	1.2	1.6	4.7
54.0	.92	1.2	1.4	2.6	6.6
72.5	.75	.81	1.3	3.3	10.0

TABLE II

EFFECT OF ADDED ASCORBIC ACID AND STORAGE TIME ON pH OF TOMATO JUICE

Ascorbic Acid Concentration mg/100ml	Storage Time (months) 3	6	9
		pH	
16.6 (no fortification)	4.57	4.50	4.43
28.4	4.56	4.52	4.44
41.1	4.55	4.51	4.43
54.0	4.55	4.51	4.42
72.5	4.54	4.50	4.41

CELL WALL COMPONENTS AND TOMATO JUICE CONSISTENCY

by

David E. Crean

INTRODUCTION

Consistency is an important quality attribute in tomato products, notably those deriving from tomato juice - puree, ketchup, concentrate, paste, etc. The effects of certain processing variables, especially break temperature, on consistency are well established due to considerable research over the years into the enzyme mechanisms controlling viscosity. These factors have been identified as the enzymes affecting the pectic substances (the pectinases and pectases) and to those acting on the cellulose of the cell wall (the cellulases). Less clear, however, is the effect of variety or cultivar on consistency. It is well known that juices produced from different cultivars under identical processing conditions can show widely differing consistencies and the purpose of this study is to examine this.

Tomato juice is a suspension of whole cells and cell wall fragments in a clear, viscous serum. From elementary physical considerations, the viscosity or consistency of tomato juice depends on:

1) the intrinsic viscosity of the serum
2) the size of the cells and cell wall particles
3) the distance separating these particles from each other (i.e. the concentration of these particles).

It was felt that these variables were susceptible to measurement and the relative contribution of each to tomato juice consistency assessed.

MATERIALS AND METHODS

Tomato juice, processed under carefully controlled conditions consistent with good commercial practice in the OSU Department of Horticulture pilot plant, was kindly supplied by Dr. W.A. Gould. Three cultivars - Ohio 38-70; Ohio 15-70; and Chico III - from the 1971 crop were studied. Data for the consistency were obtained from the efflux time, in seconds, of 100 ml of juice in the GOSUC viscometer.

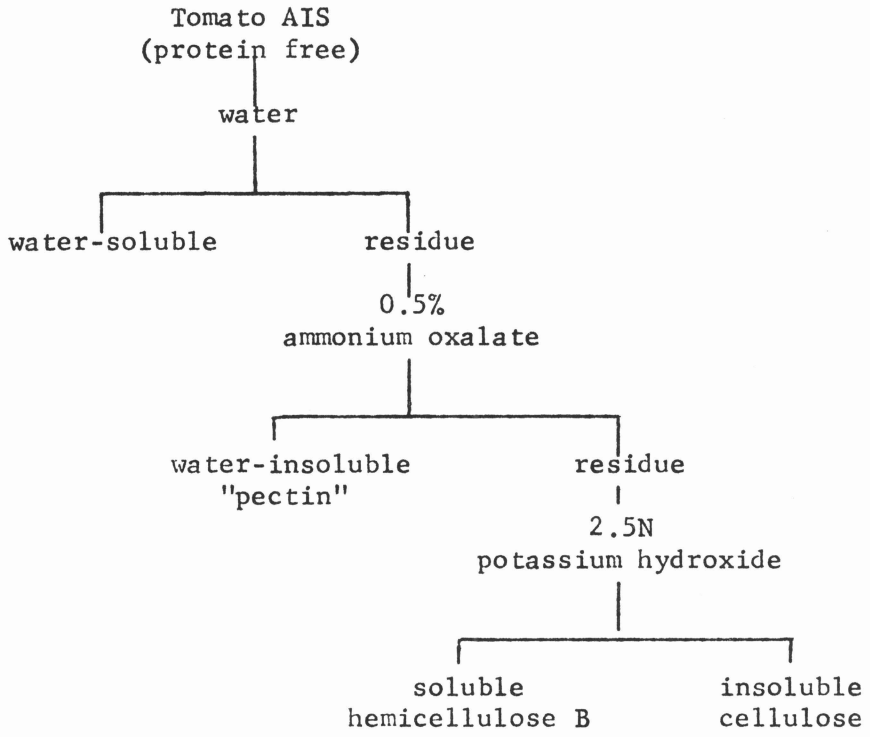
Serum viscosity measurements were made on the filtered supernatant from juice centrifuged at 5,000 x g for 10 minutes. An Ostwald pipet was used to make the measurements which were made at 30°C relative to water. Solids volume measurements were made on the centrifuged juice by subtracting the volume of the serum after centrifuging from the volume of the whole juice (100 ml).

Total solids were measured by drying 10 ml of juice at 100°C to constant weight.

MATERIALS AND METHODS (continued)

Alcohol insoluble solids (AIS) were prepared by the addition of four volumes of 95% ethanol to tomato juice (100 ml). The solids were collected by centrifugation and washed with alcohol followed with acetone on a filter paper until the washings were colorless. The AIS were dried at 80°C for 24 hours and weighed.

For studies on the composition of the cell wall, tomato juice was deproteinized by treatment with the enzyme Pronase (Calbiochem) at pH 7.2 for 18 hours. The cell wall fraction was then prepared as described above for AIS and, after drying, ground to pass a 40 mesh sieve. The cell wall material was then fractionated according to the following scheme, being washed with acetone, dried, weighed and reground after each extraction.



RESULTS

The effects of serum viscosity, total solids, AIS and solids volume on consistency are shown in Table 1. From the data, it is clear that there is no simple relationship relating serum viscosity and AIS (a measure of the cell wall solids content) to the consistency of the whole juice. However, there does appear to be a relationship between consistency and solids volume. It therefore follows that solids volume may be affected by the chemical composition of the cell wall.

RESULTS (continued)

The results of the fractionation study for two of the cultivars are shown in Table 2. From these it seems that the water-soluble pectin content affects serum viscosity which is only to be expected from previous work. The pectin, however, has a surprisingly low intrinsic viscosity. In an experiment using a commercial pectinase preparation to degrade the pectin, it was found that this was surprisingly resistant to hydrolysis. This indicates a high degree of methoxylation and some preliminary results bear this out.

It is thought that the hemicellulose and cellulose are the governing factors in the contribution of the cell wall solids to tomato juice texture. The fractionation studies have shown that the cohesiveness of the solids is destroyed when the hemicellulose is removed. It seems likely, therefore, that the hemicellulose is of greater importance than was originally supposed.

The hemicellulose is entirely in the B form - i.e. it is not precipitated upon neutralization of the alkaline extract. Iodine precipitation whoes that it is 90% in the branched form. Thin-layer chromatography of the component sugars show no difference in composition. However, the recent acquisition of a new research gas chromatograph will enable quantitative studies to be carried out and may shed some light on the chemical nature of this and other cell wall fractions. Finally, experiments with a commercial cellulase preparation indicates that tomato "cellulase" may, in fact, be a hemicellulase.

TABLE 1

VISCOMETRIC PROPERTIES OF TOMATO JUICE

	Ohio 38-70	Ohio 15-70	Chico III
Viscosity (seconds)	36.8	39.1	43.9
Serum viscosity (relative to water)	1.1566	1.1748	1.1725
Total solids (%)	5.29	6.55	5.49
AIS (%)	0.597	0.767	0.749
Solids volume (%)	9.93	13.10	13.60

TABLE 2

CHEMICAL COMPOSITION OF TOMATO CELL WALL SOLIDS

	Ohio 15-70	Chico III
Protein (%)	18.40	18.60
Water-soluble "pectin"	36.82	33.47
Water-insoluble "pectin"	7.35	7.73
Hemicellulose	12.13	13.18
Cellulose	25.30	27.02

LIPID CONTENT OF CABBAGE & SAUERKRAUT

by

Andrew C. Peng

Golden Acre Yellows Resistant cabbage (Brassica oleracea var. capitata, L.) was obtained from the Ohio State University Horticultural farm in Columbus. The cabbage was fermented into sauerkraut, canned, processed, stored at room temperature, and analyzed chemically and organoleptically at 0, 2, 4, 8 and 12-month intervals (0- and 2-month analyses have been completed). Moisture was determined.

Lipids were extracted by the procedure of Bligh & Dyer (2) with Folch reagent (3) from duplicate samples. Solvent was removed by a rotary evaporator at a reduced pressure, and the dried sample was stored in a vacuum desiccator until a constant weight was obtained.

The lipid classes were separated by column chromatography. Nonpolar and polar lipids were separated by silicic acid column (8) by chloroform and methanol respectively with an elution ratio of 25 ml solvent per gram adsorbent at a flow rate of 0.5 ml per minute. Glycolipids and phospholipids from polar fraction were recovered by a Florisil column and eluted by acetone (8) (40 ml per gram adsorbent) and methanol (6) (25 ml per gram adsorbent) separately. Their purity was checked by thin-layer chromatography on silica gel G. The developing solvent for neutral lipids was chloroform and a system consisting of chloroform: acetone: methanol: acetic acid: water (65:20:10:10:3 by volume) (4) was for polar lipids. Phosphomolybdic acid was used for the detection of neutral lipids and glycolipids and ninhydrin solution was employed to detect -amino-containing phospholipids. The separation of glyco- and phospholipids was also confirmed by anthrone procedure (7) and phosphorus determination (1).

The average moisture content for fresh cabbage was 93.00% and 91.60% for the sauerdraut. The fresh cabbage contained 0.16% total lipids, and 0.22% after processing as sauerkraut. Neutral lipids were 51.02% in fresh cabbage, and 55.84% at 0-month storage as sauerkraut and 58.17% after 2-month storage which were 9.44% and 4.17% increased respectively. Glycolipids decreased from 40.78% in the cabbage to 36.81% and 34.79% after 0- and 2-month storage as sauerkraut, this showed 9.73% and 5.48% reduction. Phospholipids were the least one contained and reduced from 8.18% to 7.23% and 7.03% with a 11.61% and 2.76% rate of change.

The results of organoleptic evaluation indicated that judges preferred 2-month old sauerkraut better than the control (0-month), this was probably due to the flavor produced by the reaction of tin and the kraut. Judges and judge-treatment interaction were significant at 5% probability level while the treatment was significant at 1% level.

Each fraction will be methylated by Metcalfe method (5) using BF -methanol. The methylesters of fatty acids in each lipid class and their change will be analyzed by gas-liquid chromatography.

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CANNED RICE-TOMATOES

by

Teung Chin and Wilbur A. Gould

A new canned product was developed using long grain milled rice (Bella Patna), rehydrated with tomato juice, canned with stewed tomatoes, salt and citric acid.

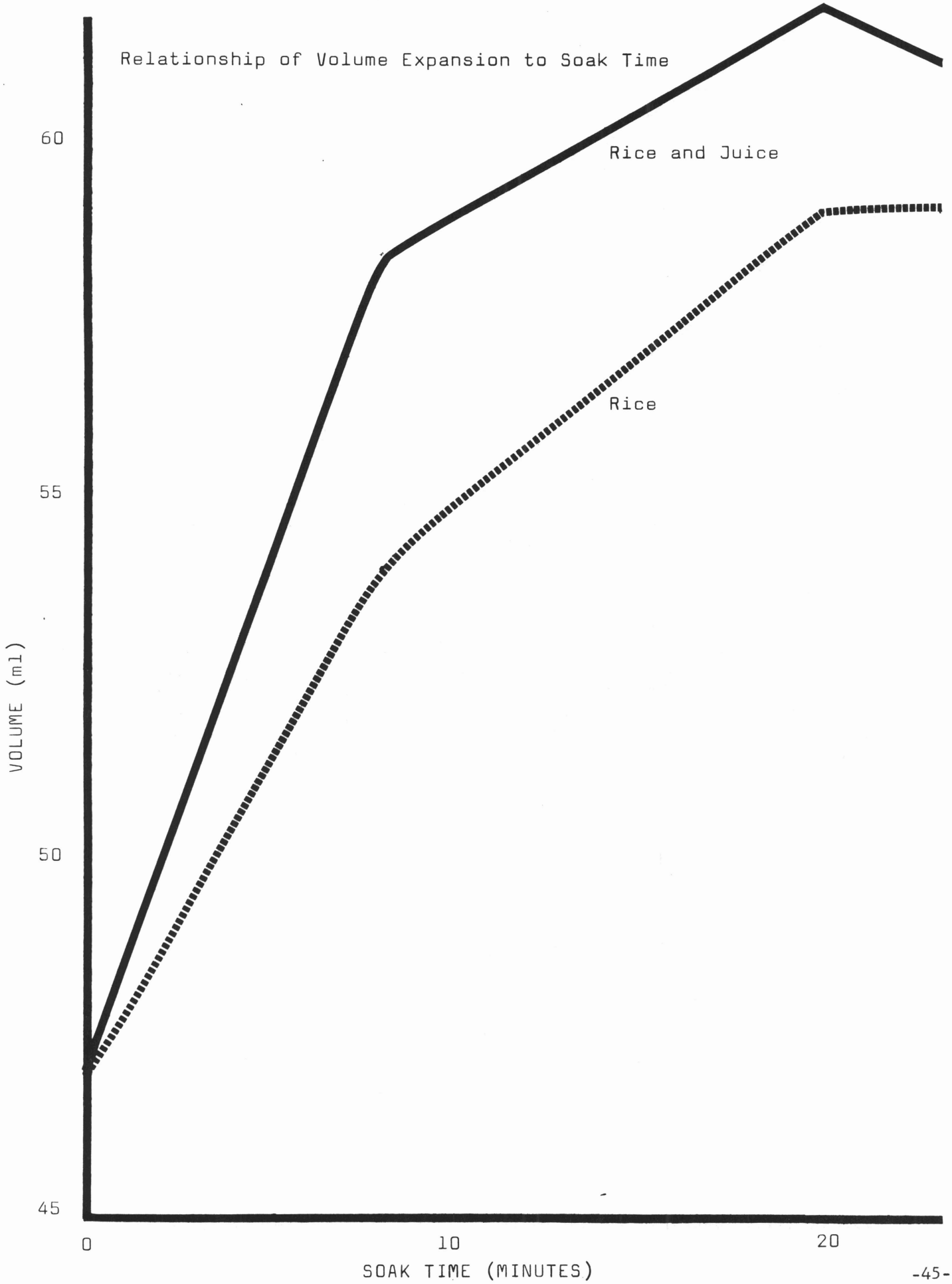
The rice was rehydrated by boiling in tomato juice for 15 minutes. The ratio of juice to dry rice was 65 to 20 ml. The hot rice-tomato juice was mixed with stewed tomatoes in a ratio of 2/3rds rice tomato juice to 1/3 stewed tomatoes. It was filled hot into enamled lined cans (303 x 406), a 30 grain salt tablet was added, acidified with citric acid to a pH of 4.3, exhausted for three minutes, closed with a 006 American Can closing machine, retort processed for forty minutes, at 240°F. (10 psi) and cooled to 100°F. The product was warehoused for 3 months prior to evaluation.

The new canned product was evaluated for quality attributes by comparing to the fresh unprocessed product prepared as above, to a product prepared in water rather than tomato juice, and four commercial samples purchased from the Columbus market. Commercial Sample A was significantly preferred for flavor over the new sample. The new canned product was significantly preferrd over the Commercial Sample B for texture. More importantly the new canned sample was siginificantly preferred over the sample prepared in water for all attributes of quality. These data are presented in Table I. The flavor difference is not of serious concern as this can be developed further by altering the stewed tomato formulation in terms of seasonings, that is, onions, peppers etc.

In the soaking operations, longer periods of soak will increase the expansion volume substantially as shown in Chart I, however, extended soak times increases the tendency of the rice kernals to break up after processing. Further, in the acceptance studies a semi-solid product was desired rather than the semi-liquid product as found with the existing commercial samples evaluated. The new product has an attractive pinkish color for the rice, good flavor, and by using the tomato juice and the tomatoes the rice is improved as a food in that both Vitamins A and C are increased with at least, one-third of the R.D.A. values.

TABLE I

	Color	Texture	Consistency	Flavor
Canned Product	6.85	5.88	5.78	5.22
Fresh Product - cooked in tomato juice	7.00	6.11	6.22	6.67
Fresh Product - cooked in water	2.77	4.00	3.33	3.22
Commercial Sample A	6.00	6.77	6.11	7.22
Commercial Sample B	5.22	4.55	4.78	4.77
Commercial Sample C	6.33	5.22	5.00	5.77
Commercial Sample C duplicate	6.44	5.66	5.11	6.11
Least significant difference at 1% level	1.55	1.37	1.44	1.78


Relationship of Volume Expansion to Soak Time
60
55
50
45
VOLUME (ml)
Rice and Juice
Rice
0
10
20
SOAK TIME (MINUTES)

DEVELOPMENT OF A CANNED PECAN PIE FILLING

by

W.A. Gould and S. Perryman

INTRODUCTION

With the increase of convenience foods on grocery shelves, food technology must continue to meet the challenge by supplementing the market with more and better products for the homemaker of the "use right from the can" variety. In general, today's homemaker is primarily concerned with obtaining food products which allow ease of preparation and which simulate the quality of home-prepared foods.

The objective of this study was to develop a pecan pie filling which could withstand processing and which would approximate the homemade version. Because eggs were omitted from the processed product and water-soluble gums substituted, factors affecting acceptability of the product as well as the ability to withstand processing were highly important.

REVIEW OF LITERATURE

It has only been recently that the emulsifying and thickening properties of eggs has had a replacement in the food industry. The substitute has been in the form of gums and alginates. The widespread use of these colloids has increased the availability of convenience food items. Previous research by companies manufacturing food additives, specifically water soluble gums, indicates a need for knowledge of their chemical and physical properties prior to use.

Locust bean gum is a water soluble gum which acts as a stabilizer and serves to replace part of the starch in pie fillings. This results in a pie filling with improved clarity and with a less starch taste. It gives improved body to the filling and aids in preventing syneresis. Locust bean gum swells in cold water, but hydrates completely upon heating (Furia, 1968).

Solutions containing locust bean gum have no gelling properties if used alone, but when used in combination with Keltrol, a gel will result. Locust bean gum will form a very heavy, non-flowing paste when used alone. Keltrol is an xanthum gum which functions as a hydrophilic colloid to suspend, emulsify, thicken and stabilize water based systems.

Keltrol and locust bean gum solutions are pseudoplastic. As the rate of shear increases, the viscosity is lowered. However, this change of viscosity is completely reversible and occurs immediately with a change of rotational speed. This pseudoplastic nature also contributes to the property of suspension of fine particles.

Temperature has little effect on the viscosity of these solutions. The viscosity will decrease as the temperature of the solution rises, but this change is reversible upon cooling.

METHODS

A basic sugar-syrup formula was established as a result of several trial runs after which only the starch and gums were varied proportionately. On the basis of taste panel data, new pies were reformulated by increasing or decreasing the variable ingredients.

Twenty-four grams of sugar and a specific amount of modified starch were combined to prevent lumping of the starch granules with the addition of liquid. One cup plus two tablespoons of syrup and one-half cup of water were combined and gradually added to the dry ingredients. This mixture was cooked until it boiled, then removed from the heat and poured into a blender. One and two-tenths grams of dry milk powder was added to the previous ingredients along with one-fourth teaspoon of pecan flavoring.

The Keltrol and locust bean gum were each introduced into two and one-tenth grams of oil which acted as a dispersant. The suspension properties of the gums aided in preventing oil drops from separating out. Then three tablespoons of water was gradually added to the oil for each of the gums while using strong agitation until a thick white paste formed. It was found that clumping readily occurred if the gums were introduced into water alone. This retarded hydration and, hence, complete solubility.

Use of the blender was necessary to sufficiently incorporate the gums into the final product. The mechanical process of blending did not permanently affect the viscosity of the final product. All the ingredients were blended for 30 seconds, after which the thin mixture was poured into glass jars. The samples were processed while hot and sealed. During a minimum 24-hour air-cooling period, the samples thickened and then were spread in prepared frozen pie shells, sprinkled with pecans, and baked in a stack-type oven at 350 degrees Farenheit for 35 minutes. The pies were then removed from the oven. The reversible effect of temperature application allowed for the dual heat processing of the pie filling -- once in canning and again in baking. The pies were allowed to come to room temperature before evaluation by a taste panel. A minimum two-hour cooling period was allowed for attainment of maximum viscosity and development of optimum consistency.

Acceptability was determined by use of the hedonic scoring system. Each pie was scored for flavor and consistency on a ten-point scale. Ten was rated as perfect; nine, eight and seven as good; six, five and four as fair; three and two as poor; and one as unacceptable. The sample pies were scored by 20 college-age students in the food technology program. Data was analyzed statistically by means of the Analysis of Variance.

RESULTS AND DISCUSSION

The results from the taste panel indicated that the judges were unable to detect significant differences of flavor and consistency among the four best samples. The mean scores for the factors of consistency and flavor are shown in Table I.

Table I. Mean Scores for Quality Factors in Pecan Pie Filling.

	Variables			Mean Scores for Factors	
Samples	Keltrol	Gum	Starch	Flavor	Consistency
1	*0.2%	0.2%	4.5%	7.1	7.1
2	0.25%	0.25%	4.5%	7.1	6.9
3	0.25%	0.25%	5.0%	7.3	6.9
4	0.2%	0.2%	4.0%	7.2	6.8

*Percentages were based on a 600 gram formula.

Though the average scores for flavor only varied by two-tenths and for consistency by three-tenths, the judges seemed to show a slight preference for the flavor of sample number three and for the consistency of sample number one. However, the scores indicated that all four samples rated fair to good for consistency and good for flavor. Typical comments from the panelists were: too gummy, too rubbery. No one sample had a high over-all score.

The non-specific results from the judges indicate several possibilities. One is that a slgiht variation in formula apparently was of little consequence in the acceptability of the final product. The amount of locust bean gum and Keltrol could vary from 0.2% to 0.25% in the pecan pie filling. The range of variation of the starch content was from 4.0% to 5.0% which was slightly higher than that afforded by the gums.

The pH values for the above samples ranged from 6.45 to 6.50 indicating a need for the samples to be acidified to reduce the pH in order to fulfill shelf-life requirements.

The amount of flavoring used was held constant in all four samples. The judges indicated only a slight variation in flavor preference among the samples. This indicates that the thickeners did not affect the flavor of the final product.

A second series of samples were formulated in which the flavor was altered by varying the sugar solids content. This was accomplished by adding various forms and amounts of sugar. The base formula which contained only syrup as a source of sugar approximately 50% sugar solids. Granulated white sugar, brown sugar, molasses and combinations of these were added at graduations of 5% up to 15% for each form of sugar. These were scored for flavor and the two best samples were chosen for further evaluation. These were: (a) 5% brown sugar, and (b) 5% brown sugar and .25% molasses.

These two samples were made by substituting twenty-wight grams of brown sugar in sample number one for twenty-four grams of granulated white sugar previously used, and twenty-eight grams of brown sugar and three grams of molasses for sample number two. The percentages of thickeners used were .25% Keltrol, .25% locust bean gum and 4.5% starch which received a mean score of 6.9 for consistency previously. The procedure was the same used prior to this with the only difference being the addition of molasses before blending for sample number two.

After blending, the pH was lowered to 4.5 by the addition of two to three tenths grams of citric acid. The hot mix was then filled into No. 303 fruit enamel cans and sealed. Several cans were thermocoupled and all samples were retorted for 90 minutes (the internal center temperature was 240°F). These were then cooled in cold water. After the canned fillings reached room temperature, they were poured into frozen prepared pie shells, topped with pecans and baked as previously described.

Both samples were evaluated by a taste panel. Sample number one received a mean score of 8.6 for color, 8.5 for flavor and 8.0 for consistency. Sample number two received a mean score of 8.0 for color, 8.6 for flavor and 8.1 for consistency. Scores indicated both samples were rated good for all three attributes. The addition of molasses to sample number two did not appear to affect the flavor either favorably or unfavorably. However, the panelists seemed to prefer the lighter color of sample number one to the darker color of sample number two. The darker color was due to the addition of molasses.

The improved flavor of the product may be responsible for the increase in mean score for consistency from 6.9 to 8.0. The close scores of 8.0 for sample number one and 8.1 for sample number two for consistency were anticipated since the proportions of thickeners used were the same in both samples. It should be noted that the presence of citric acid was not detectable in flavor analysis.

Our best formula to date is 4.5% modified starch, .25% Keltrol, .25% locust bean gum, one cup plus two tablespoons syrup, one cup plus two tablespoons water, one-fourth teaspoon pecan flavoring, one and two-tenths grams powdered milk, four and two-tenths grams oil, twenty eight grams brown sugar, and two to three-tenths grams citric acid. The ingredients are combined by the same method as described earlier, substituting brown sugar for white granulated sugar. Citric acid, which was not used in the first series of samples, is added to the hot mix, evenly blended and the pH measured at intervals until a level of 4.5 is obtained. The pH meter was adjusted for the temperature of the mix.

CONCLUSIONS

Development of a canned pecan pie filling without eggs and thickened with a modified starch and water soluble gums may soon be available to the consumer. The results of a taste panel evaluations indicate that a marketable pecan pie filling in canned or glass form can be formulated with the basic structure as described above.

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A NEW SOYBEAN FOOD FROM TEMPEH

by

Nasruddin Iljas, Wilbur A. Gould and Andrew C. Peng

Tempeh, the Indonesian fermented soybean food, has been reported to be more nutritious and more digestible than plain cooked soybeans. The advantages of this food over other fermented soybean foods are the simplicity of its preparation and the short fermentation time. It has a bland but attractive flavor and the objectionable beany flavor of raw soybeans is eliminated by the fermentation and preparation.

This food has also been reported to be acceptable to Americans and Europeans. However, the consumption of tempeh as it is, i.e. by cooking in its original form, does not appear to be highly favorable. This is believed due to the differences in eating habits and probably, also, because the flavor is too bland.

A tempeh-based food was developed at the Department of Horticulture, The Ohio State University, using tomato products as the second ingredient. Tempeh used in this experiment was prepared from Ohio grown Shelby soybeans and fermented with the tempeh mold Rhizopus oligosporus NRRL 2710. Eight tomato products were evaluated during the development of this food, e.g. chili sauce, cocktail sauce, and canned whole tomatoes. The ratio between tempeh and tomato products and also the form and preliminary treatment of tempeh for this new food were evaluated. After six stages of development and evaluation, an acceptable formulation was obtained. One hundred grams of freshly made, unblanched tempeh was blended with 200 grams of chili sauce and 200 grams of tomato sauce in a Waring Blender for about 15 seconds in order to break the soybean cotyledons but maintaining large particles. This mixture was then cooked under low heat until bubbling ceased which took about 15 minutes. A small amount of dehydrated onion soup, minced garlic, and black pepper was added to the mixture before cooking. The acceptability score of 8 was given by a trained taste panel of 8 tasters on a 1 to 10 scale with 1 being off and 10 perfect. This new food had a bright tomato red color and looked like "sloppy joes".

Using this final, acceptable formulation more product was prepared. One portion of this product was canned and heat-processed for 60 minutes at a retort temperature of 240°F, the second portion was filled into glass jars and kept frozen at 5°F in a home refrigerator, and the third portion was freeze-dried. After two weeks of storage, the physical and chemical properties of these samples were evaluated and compared with the samples cooked and uncooked prior to further treatments. In addition, raw soybeans and tempeh were also analyzed.

The result on color measurement by a Hunter and Color-Difference Meter showed very slight changes of color due to treatments (Table 1). The pH value of the product was very close to the dividing line between medium-acid and acid food groups and was practically unchanged, however, its consistency in terms of relative viscosity was altered by the treatments and preparation (Table 2). The protein, lipid, and ash contents of this tempeh-based food (Table 3) were not affected by treatments as statistical analysis indicated that the differences in nitrogen, lipid, and ash among the samples were insignificant. However,

the differences in nitrogen, lipid, and ash contents between tempeh and raw soybeans were significant at 1% level. Amino acid composition of the samples was also determined and their protein scores with egg protein as reference were calculated. The results showed that the limiting sulfur-containing amino acid of soybean protein was improved by fermentation, while the amino acid composition of tempeh-based food was slightly altered.

This study revealed that a food from tempeh acceptable to American taste could be made by incorporation with tomato products. For commercial production, however, raw tomatoes should be used with necessary spices added. This food contains more protein than plain tomatoes (ripe tomatoes contain about 17% protein on a dry basis). The use of tempeh in this formulation is desirable because of its higher nutritional quality than plain cooked soybeans or isolated soybean protein, while the objectionable beany flavor is not present. Furthermore, the large cotyledon particles of tempeh in this new food presents a very pleasing texture. This new food can be further fortified by adding necessary vitamins and minerals for nutrition-conscious consumers. Other ingredients, such as meat and vegetables, may also be added to make it more appealing and satisfying. This food may be consumed as a sandwich spread, TV dinners, or for the main dish. Finally, commercialization of such food will certainly increase the use of U.S. soybeans for food.

TABLE 1
HUNTER COLOR AND COLOR DIFFERENCE METER VALUES
OF TEMPEH-BASED FOOD SAMPLES

Sample	L[1]	a_L[2]	b_L[3]
Uncooked product	34.0	+20.1	+17.0
Cooked product	32.7	+20.3	+16.7
Canned product	31.8	+18.0	+16.4
Frozen product, thawed	35.4	+19.6	+17.3
Freeze-dried product, rehydrated	38.1	+18.2	+18.3

1) L notation indicates visual lightness.
2) a_L notation indicates red-green values.
3) b_L notation indicates yellow-blue values.

TABLE 2
THE pH AND RELATIVE VISCOSITY VALUES OF TEMPEH,
SAUCE MIXTURE, AND TEMPEH-BASED FOOD SAMPLES

Sample	pH	RV*
Tempeh, freshly made	7.09	--
Sauce mixture	4.10	0.27
Uncooked product	4.44	1.27
Cooked product	4.45	3.08
Canned product	4.47	3.06
Frozen product, thawed	4.49	3.76
Freeze-dried product, rehydrated	4.62	11.33

* Relative viscosity as measured by a Stormer viscosimeter at 68°F with castor oil as reference.

TABLE 3
CHEMICAL COMPOSITION OF SOYBEANS, TEMPEH,
AND TEMPEH-BASED FOOD SAMPLES (in percent dry basis)

Sample	Protein[1]	Lipid	Ash	Carbohydrate[2]
Soybeans, raw, dehulled	45.19	22.50	5.10	27.21
Tempeh, freshly made	54.56	14.05	--	27.91
Uncooked product	21.50	7.13	10.79	60.58
Cooked product	20.75	6.32	10.83	62.10
Canned product	24.31	6.72	10.69	58.28
Frozen product	23.81	7.10	11.24	57.84
Freeze-dried product	22.69	6.94	11.39	58.98

1) Protein calculated by multiplying nitrogen content by 6.25.
2) Carbohydrate content by difference.

REHABILITATION AND RECYCLING SPENT CUCUMBER PICKLING BRINES

by

J. R. Geisman and R. E. Henne

Sodium chloride (salt) is a necessary ingredient for curing cucumbers. After curing the pickles are removed from the brine and the brine has traditionally been discarded. Disposing of the brine is costly since salt is non-biodegradable. Dilution is the most common means of disposing of salt. Since in Ohio alone it has been estimated that there is in excess of two million gallons of concentrated (10-18% salt) brine annually, the volume required for dilution becomes astronomical in size. It is readily apparent that a sizeable savings would result if the salt could be recycled.

In addition to salt, the spent brines also contain soil carried in with the fruit, cucumber constituents leached from the fruit, and residues from the microorganisms involved in the fermentation. These materials are all dispersed throughout the spent brine and constitute the suspended solids that must be removed if the brine is to be recycled.

MATERIALS AND METHODS

Laboratory studies were initiated to screen standard water-treatment chemicals for coagulation of suspended solids. For this purpose spent brine was obtained from an Ohio pickle processor.

Using the treatment which produced maximum coagulation, the laboratory tests were increased in scale. An attempt was also made to continuously filter the treated brine.

Detailed chemical analyses were conducted on the brines and residues for mineral content, salt content, carbohydrate and protein residues, and acidity. Protein was of particular importance due to the possibility of the presence of a softening enzyme. This enzyme would lead to decreased quality of the next crop of cucumbers placed in the brine.

Research was also conducted at a pickle processing plant using larger quantities of spent brine to determine operating costs and feasibility of operation.

RESULTS

Five water-treatment chemicals were screened both singly and in combination. The results are summarized in Table 1.

Sodium hydroxide was effective and inexpensive. This chemical was used in further trials.

It was found that by adjusting the brine pH to 11.0 with sodium hydroxide resulted in a heavy precipitate. Also at this pH no protein was found in the filtrate.

RESULTS (continued)

A laboratory scale filter was constructed complete with an activated charcoal bed for final filtration. This apparatus performed well under laboratory conditions. The end product was a clear, colorless brine containing no carbohydrates or proteins. A final pH adjustment was made with hydrochloric acid to the neutral point. This pH adjustment produced salt and water.

After extensive tests at the pickling plant, it was decided to decant the brine from the precipitate instead of pumping and filtering. This elimination of this operation reduced the cost considerably. The cost for treatment of spent brines was calculated and is presented in Table 2. Although the cost of treating a tank of cucumbers was $10.00, the treatment saved 21.38 cwt of salt. Using $1.00 a cwt as the cost of salt, a savings of $11.38 per tank resulted. Thus to treat the spent brine for reuse actually resulted in a savings to the processor. The savings on salt alone does not reflect the total savings on such items as volume disposed, surcharge on waste strength load and salt transportation and storage, to mention a few.

Cucumbers are currently undergoing fermentation in recycled brine and will be evaluated for quality during next year. Further investigations will be conducted on recycling the salt from other operations in pickling cucumbers.

TABLE 1

SUMMARY EVALUATION OF STANDARD WATER-TREATMENT CHEMICALS FOR ABILITY TO COAGULATE SUSPEND SOLIDS IN SPENT BRINE

Chemical	Concentration Range Evaluated (ppm)	Effective Range (ppm)	Comments
Aluminum Sulfate	100- 4,000	None	Ineffective
Calcium Oxide	100- 1,200	1,100-1,200	Expensive
Sodium Hydroxide	1,000- 2,500	1,800-2,500	Effective
Sodium Carbonate	3,120- 5,400	4,350-4,600	Expensive
Agricultural Lime	2,500-16,250	None	Ineffective
Agr. Lime and Sodium Carbonate	2,500- 6,250 1,000- 3,000	6,250 + 3,000	Ineffective

TABLE 2

COST OF CHEMICALS TO TREAT SPENT PICKLING BRINES

Chemical	Cost/tank (690 bu.)
Sodium hydroxide	$ 5.00
Hydrochloric acid	5.00
Total Cost	$10.00

Evaluation of Several Grape Cultivars for Wine Making

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Present studies concerning fruit processing at the Research Center include (1) the factors affecting the induction of malo-lactic fermentation in Ohio table wines, (2) the influence of processing techniques and fruit varieties on finished product quality, and (3) the feasibility of concentrating fruit juices by reverse osmosis. Within this research program, studies involving the evaluation of grape cultivars for wine and other grape products have been in progress for several years. Publications of this research and malo-lactic studies of Ohio wines are listed for reference at the end of this report.

Since the processing quality of standard eastern cultivars such as, Catawba, Delaware and Concord has been established, this investigation is concerned with the wine making suitability of several relatively new grape cultivars and selections in Ohio. The results of this report seem appropriate, since the Ohio wine industry is currently showing growth and commercial success. This success in Ohio and also in the eastern United States is attributed partially to the production of high quality table wines. In order to maintain and strengthen the demand for eastern table wines, new wine cultivars and selections are constantly being sought by wineries. These grapes should possess excellent yields and produce distinctive wines with a somewhat neutral character. These will give eastern vintners an opportunity to complement their classic and ever-popular labrusca wines with more neutral type wines.

Since the trend is toward wines that lack labrusca character, the first consideration of this study was to evaluate the cultivars and selections for "foxiness" which is associated with standard American grapes. Other essential points (composition, character, maturity, etc.) were also considered in determining their suitability of making wine.

The cultivars and selections included the following: standard American cultivars, French hybrids, New York hybrids, Canadian hybrids and Virginia hybrids. Some of these grapes were developed by breeding programs at the Horticultural Research Institute, Vineland, Ontario; New York Agricultural Experiment Station, Geneva, New York and Virginia Polytechnic Institute, Blacksburg, Virginia. The results of this report summarize the findings of those grapes that were evaluated during the 1971 season.

PROCEDURE

Each cultivar was harvested at maturity and transported to the OARDC Department of Horticulture in Wooster for wine production. The grapes were stemmed, crushed, and transferred to stainless steel or glass containers. A representative must sample was obtained and analyzed for the following:

1. pH: The pH was determined by the glass electrode method (Beckman Zeromatic pH meter) using grape juice of each cultivar.

2. Total Acids: A 10 ml. grape juice sample was titrated with a 0.1 normal sodium hydroxide solution to a pH of 8.2. The percent total acids was calculated as tartaric.

3. Total Soluble Solids: The soluble solids content was determined by using an Abbe refractometer.

From the soluble solids reading (an indication of sugar content), the amount of sugar needed to bring the original soluble solids content of each cultivar to 22% was calculated. The required amount of sugar (sucrose) was added and dissolved in the crushed grapes. Then, the musts were treated with 100 ppm of sulfur dioxide in the form of potassium metabisulfite (57.6% sulfur dioxide).

After 3 hours, the must from white grapes were pressed and the juice was ameliorated with 21 percent sugar syrup to 15 percent of the resulting volume. Then, the juice was transferred to glass carboys and an active yeast culture was added to the juice, one percent by volume.

For the red, blue and black grapes, the musts were inoculated with an active yeast culture (1 percent by volume) 3 hours after the sulfur dioxide treatment. The fermenting crushed grapes were stirred twice daily and were pressed approximately 4 days after the yeast was added to the musts. Then, the fermenting juice was ameliorated with 21 percent sugar syrup to 15 percent of the resulting volume and transferred to glass carboys.

All carboys were equipped with "water seals", and were placed in 65° F. storage for fermentation. The fermentations were essentially completed in 4 weeks, and the wines were racked at this time to clean glass carboys. After additional rackings (over a 6 months period), the wines were placed in cold storage (30° F.) for approximately 3 weeks to precipitate the excess tartrates. The wines were racked, bottled and placed back into 65° F. storage. After one month of storage, they were analyzed for composition and quality. The following chemical constituents were determined:

1. pH: The pH was determined by the glass electrode method (Beckman Zeromatic pH meter) using wine of each cultivar.

2. Total Acids: The wine was titrated with a 0.1 normal sodium hydroxide solution to a pH of 8.2. The percent total acids was calculated as tartaric.

3. Alcohol: The alcohol content was determined by using an ebullioscope, Bujardin - Salleron Type.

4. Tannin: The tannin content was determined by using the standard (Pro) procedure.

5. Extract: The extract of the wines was determined by obtaining the density of a dealcoholized sample.

DISCUSSION OF RESULTS

The results of the chemical analyses for each of the various grape musts are shown in Table 1. These results represent an average of three must samples obtained from each cultivar or selection at the time of crushing. The pH of the must samples varied between 2.93 (S.V. 12375) and 3.46 (Ravat 578 and V. 53043). The total acids varied widely with the French hybrid Seibel 8357 having the highest percent, 1.50 and the Virginia hybrid V.P.I. 26 the lowest percent, 0.46. The cultivars and selections highest in percent soluble solids were: White Baco (21.6%), Ravat 578 (21.0%), V.P.I. (20.2%), Ravat 51 (20.4%), Delaware (19.7%) and V.P.I. (19.4%).

The analytical data of the composition of the wines are summarized in Table 2. The French hybrid S.V. 5247 was highest in pH, 3.66, while the standard American cultivar Catawba was lowest, 2.84. The results of the total acidity indicated that the wines varied widely with a range between 0.50 percent (Delaware) to 1.02 percent (Seibel 8357). Generally, a total acidity level of approximately 0.65 percent is an acceptable value of most dry table wines. The alcohol content of the wines tended to be within a narrow range, 10.8 to 13.8 percent for grapes Seibel 8357 and Romulus, respectively. The extract value is a measure of the wine's alcohol-free soluble solids and indicates the amount of body the wine possesses. The Canadian cultivar Vincent was highest in extract content, 2.5 mgs. per 100 c.c., while several varietal wines were lowest, 1.3 mgs. per 100 c.c. The wines highest in tannins were Seibel 8357 (287.0 mgs. per 100 c.c.) and Vincent (201.0 mgs. per 100 c.c.). The tannin content is usually associated with the astringency of the wine.

In addition to the analytical results, Table 2 includes brief statements of the sensory examination of the selected wines. The results of this study and previous investigations indicate that Baco #1, Seibel 9549, Seibel 7053, Seibel 10878, Seibel 5779, S.V. 12375, S.V. 5276 and Vidal 256 were found best for making non-labrusca type wines. Other wines which were found to possess good potential include: Veeport, Vincent, V. 51061, V. 53043, V. 51011, Ravat 34 and Ravat 51. However, these grapes are relatively new to the Research Center's vineyard and have not been fully evaluated. This list is in contrast to those cultivars which are recommended for making the fruity "labrusca" type wines. These include Catawba, Delaware, Niagara and Concord.

TABLE 1.--Composition of Musts from Various Grape Cultivars, 1971 Season

Cultivar	Harvest	Color	pH	Total Acid %	Soluble Solids %
Baco #1 (Baco Noir)	Sept. 9	Blue	3.15	1.39	16.9
Catawba	Sept. 22	Red	3.08	0.85	16.9
Concord	Sept. 16	Blue	3.37	0.77	13.5
Delaware	Sept. 16	Red	3.35	0.64	19.7
Himrod	Aug. 25	White	3.23	0.62	17.6
Landot 244	Sept. 1	Blue	3.18	1.20	18.6
Ravat 34	Aug. 25	White	3.29	0.83	18.8
Ravat 51	Sept. 1	White	3.08	1.24	20.4
Ravat 262	Sept. 1	Blue	2.94	1.19	18.6
Ravat 578	Aug. 25	White	3.46	0.73	21.0
Romulus	Sept. 9	White	3.02	0.90	16.3
Seibel 5279 (Aurora)	Sept. 1	White	3.24	0.94	15.8
Seibel 7053 (Chancellor)	Sept. 16	Blue	3.26	0.97	15.7
Seibel 8357	Sept. 9	Blue	3.06	1.50	18.0
Seibel 9549 (De Chaunac)	Sept. 1	Blue	3.06	1.21	18.3
Seibel 10878 (Chelois)	Sept. 1	Blue	3.21	1.39	16.6
Seneca	Aug. 18	White	3.17	0.82	18.9
S.V. 5247	Sept. 1	Blue	3.28	0.85	17.3
S.V. 5276 (Seyval)	Sept. 9	White	3.19	0.74	18.1
S.V. 12375 (Villard Blanc)	Sept. 27	White	2.93	1.05	13.6
S.V. 18283	Sept. 9	Blue	3.22	0.97	18.0
S.V. 18315	Sept. 9	Blue	3.12	1.27	18.0
S.V. 23410	Sept. 9	White	3.36	0.58	16.9
Veeport	Sept. 22	Blue	3.44	0.85	16.0

TABLE 1.--Composition of Musts from Various Grape Cultivars, 1971 Season (Cont.)

Cultivar	Harvest	Color	pH	Total Acid %	Soluble Solids %
Vidal 256	Sept. 16	White	3.06	1.04	15.6
Vincent	Sept. 16	Blue	3.27	0.97	15.1
V. 35013	Sept. 1	Blue	3.08	0.99	19.2
V. 37031	Aug. 25	White	3.27	0.67	17.8
V. 51011	Sept. 22	White	3.13	0.89	15.0
V. 51061	Sept. 9	White	2.95	1.22	17.7
V. 52082	Sept. 22	Blue	3.21	0.77	12.3
V. 53033	Sept. 1	Blue	2.97	1.32	15.4
V. 53043	Sept. 9	Blue	3.46	0.94	16.1
V. 53091	Sept. 14	Blue	3.10	0.99	15.6
V. 54064	Sept. 9	Blue	3.33	0.73	14.6
V. 58011	Sept. 9	White	3.15	0.90	17.9
V. 292718	Sept. 9	Blue	3.31	0.91	13.8
V.P.I. 26	Aug. 18	Red	3.36	0.46	16.6
V.P.I. 30	Aug. 18	Blue	3.27	0.64	19.4
V.P.I. 32	Sept. 9	Blue	3.44	0.61	20.2
White Baco	Aug. 25	White	3.25	0.94	21.6

TABLE 2.--Composition of Wines From Various Grape Cultivars, 1971 Season

Cultivar	pH	Total Acids %	Alcohol %	Extract Gms. per 100 c.c.	Tannin Mgs. per 100 c.c.	Sensory Remarks
Baco #1 (Baco Noir)	3.28	0.82	12.2	2.1	107.5	Medium red, good body, neutral flavor and good.
Catawba	2.87	0.74	13.4	2.0	30.0	Light yellow, fragrant, good body, very good.
Concord	3.24	0.75	12.4	2.0	94.0	Medium red, strong labrusca, little rough, good.
Delaware	3.28	0.50	13.4	1.3	30.0	Light yellow, slightly labrusca, good body, very good.
Himrod	3.21	0.58	13.4	1.5	33.0	Light yellow, slightly spicy, flat and fair.
Landot 244	3.33	0.81	13.0	2.3	120.0	Dark red, neutral, good body, and fair.
Ravat 34	3.38	0.65	12.4	1.8	30.0	Light yellow, flowery, little rough and good.
Ravat 51	3.25	0.78	12.6	1.8	31.6	Medium yellow, good aroma, fruity and good.
Ravat 262	3.03	0.87	12.0	1.9	117.5	Dark red, vinous, thin and fair.
Ravat 578	3.45	0.59	13.2	1.7	37.6	Medium yellow, vinous, slightly rough, and poor.
Romulus	3.11	0.63	13.8	1.6	41.0	Light yellow, spicy aroma, neutral flavor, thin and good.

TABLE 2.--Composition of Wines From Various Grape Cultivars, 1971 Season (Cont.)

Cultivar	pH	Total Acids %	Alcohol %	Extract Gms. per 100 c.c.	Tannin Mgs. per 100 c.c.	Sensory Remarks
Seibel 5279 (Aurora)	3.26	0.68	12.2	1.5	30.0	Medium yellow, neutral, tart slightly fruity and very good.
Seibel 7053 (Chancellor)	3.38	0.73	12.4	2.0	135.0	Dark red, fine flavor, slightly fruity and very good.
Seibel 8357	3.07	1.02	10.8	2.1	287.0	Very dark red, neutral flavor, tart, Teinturier type and fair.
Seibel 9549 (De Chaunac)	3.30	0.77	13.0	1.9	157.5	Dark red, good aroma and body and very good.
Seibel 10878 (Chelois)	3.17	0.93	12.2	1.7	75.0	Medium red, slightly fruity, fine flavor, and good.
Seneca	3.43	0.66	13.8	1.7	33.6	Light yellow, mild labrusca, fruity and good.
S.V. 5247	3.66	0.73	12.8	1.7	80.0	Light red, vinous, flat flavor and fair.
S.V. 5276 (Seyval)	3.09	0.77	12.4	1.5	26.6	Medium yellow, fine aroma, and flavor and very good.
S.V. 12375 (Villard Blanc)	2.94	0.72	13.0	1.5	33.0	Light yellow, fine aroma and flavor, slightly rough and very good.
S.V. 18283	2.96	0.73	12.2	1.8	126.0	Dark red, good body, neutral flavor and good.
S.V. 18315	3.19	0.81	11.4	2.0	159.0	Dark red, vinous, tart and fair.
S.V. 23410	3.52	0.52	13.2	1.6	30.8	Medium yellow, vinous, neutral flavor and fair.

TABLE 2.--Composition of Wines From Various Grape Cultivars, 1971 Season (Cont.)

Cultivar	pH	Total Acids %	Alcohol %	Extract Gms. per 100 c.c.	Tannin Mgs. per 100 c.c.	Sensory Remarks
Veeport	3.42	0.65	12.0	1.9	111.0	Dark red, flowery, good body and very good.
Vidal 256	3.02	0.69	13.4	1.3	39.0	Light yellow, fine aroma, little tart and very good.
Vincent	3.46	0.74	12.4	2.5	201.0	Very dark red, good body, rough and good.
V. 35013	3.36	0.76	12.4	1.8	129.0	Medium red, slightly fruity, smooth and fair.
V. 37031	3.34	0.66	13.4	1.5	47.0	Medium yellow, fruity aroma, little flat and fair.
V. 51011	3.08	0.63	13.6	1.3	23.0	Light yellow, fine aroma, fruity and good.
V. 51061	3.18	0.80	13.2	1.6	31.0	Medium yellow, slightly fruity and rough and good.
V. 52082	3.13	0.65	12.2	1.4	79.0	Light red, slightly spicy, rough and poor.
V. 53033	3.30	0.83	12.2	1.9	156.0	Light red, poor balance, rough and poor.
V. 53043	3.53	0.62	12.8	1.5	89.0	Medium red, flowery, little rough, good body and very good.
V. 53091	3.12	0.80	12.8	1.7	76.0	Medium red, vinous, smooth, tart and good.

TABLE 2.--Composition of Wines From Various Grape Cultivars, 1971 Season (Cont.)

Cultivar	pH	Total Acids %	Alcohol %	Extract Gms. per 100 c.c.	Tannin Mgs. per 100 c.c.	Sensory Remarks
V. 54064	3.35	0.63	12.6	1.8	137.5	Dark red, mild labrusca, rough and good.
V. 58011	3.34	0.71	13.6	1.7	38.0	Light yellow, muscat, rough, thin and good.
V. 292718	3.32	0.79	12.2	1.9	154.0	Dark red, slightly labrusca, rough, tart and fair.
V.P.I. 26	3.36	0.62	12.6	1.8	77.0	Amber, slightly labrusca, neutral flavor and fair.
V.P.I. 30	3.29	0.66	13.0	1.4	82.5	Medium red, slightly labrusca, thin and fair.
V.P.I. 32	3.36	0.59	12.2	1.6	102.5	Light red, vinous, neutral flavor, flat and fair.
White Baco	3.51	0.65	12.8	1.4	43.0	Medium yellow, thin, slightly rough and poor.

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